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Environmental Impact Guidelines for New Source Leather Tanning and Finishing Industries

WAPORA, Inc.
Washington, DC

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For New Source Leather Tanning and Finishing Industries

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ENVIRONMENTAL IMPACT GUIDELINES

For New Source

Leather Tanning and Finishing Industries

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ABSTRACT

This guideline document has been prepared to augment the information previously released by the Office of Environmental Review entitled Environmental Impact Assessment Guidelines for Selected New Source Industries. Its purpose is to provide guidance for the preparation and/or review of environmental documents (Environmental Information Document or Environmental Impact Statement) which EPA may require under the authority of the National Environmental Policy Act (NEPA) as part of the new source NPDES permit application review process.

This document has been prepared in seven sections, organized in a manner to facilitate analysis of the various facets of the environmental review. The initial section includes a broad overview of the industry intended to familiarize the audience with the processes, trends, impacts and applicable pollution regulations commonly encountered in the leather tanning and finishing industry. Succeeding sections provide a comprehensive identification and analysis of potential environmental impacts, pollution control technologies available to meet federal standards, and siting and process alternatives. The document concludes with three sections: a listing of federal regulations (other than pollution control) which may apply to the new source applicant, a glossary of terms pertaining to the leather tanning and finishing industry, and a comprehensive listing of references for further reading.

Preface

This document is one of a series of industry-specific Environmental Impact Assessment Guidelines being developed by the Office of Environmental Review for use in EPA's Environmental Impact Statement preparation program on New Source NPDES permits. It is to be used in conjunction with Environmental Impact Assessment Guidelines for Selected New Source Industries, an OER publication that includes a description of impacts common to most industrial new sources.

The requirement for federal agencies to assess the environmental impacts of their proposed actions is included in Section 102 of the National Environmental Policy Act of 1969 (NEPA), as amended. The stipulation that EPA's issuance of a New Source NPDES permit as an action subject to NEPA is in Section 511(c)(1) of the Clean Water Act of 1977. EPA's regulations for preparation of Environmental Impact Statements are in Part 6 of Title 40 of the Code of Federal Regulations; New Source requirements are in Subpart F of that Part.

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INTRODUCTION

The Clean Water Act requires that USEPA establish standards of performance for categories of new source industrial wastewater dischargers. Before the discharge of any pollutant to the navigable waters of the United States from a new source in an industrial category for which performance standards have been proposed, a new source National Pollutant Discharge Elimination System (NPDES) permit must be obtained from either USEPA or the state (whichever is the administering authority for the state in which the discharge is proposed). The Clean Water Act also requires that the issuance of a permit by USEPA for a new source discharge be subject to the National Environmental Policy Act (NEPA). The procedure established by USEPA regulations (40 CFR 6 Subpart F) for applying NEPA to the issuance of new source NPDES permits may require preparation of an Environmental Impact Document (EID) by the permit applicant. Each EID is submitted to USEPA and reviewed to determine if there are potentially significant effects on the quality of the human environment resulting from construction and operation of the new source. If there are, USEPA prepares an Environmental Impact Statement (EIS) on the action of issuing the permit.

The purpose of these guidelines is to provide industry-specific guidance to USEPA personnel responsible for determining the scope and content of EID's and for reviewing them after submission to USEPA. It is to serve as supplementary information to USEPA's previously published document, Environmental Impact Assessment Guidelines for Selected New Source Industries, which includes the general format for an EID and those impact assessment considerations common to all or most industries. Both that document and these guidelines should be used for development of an EID for a new source leather tannery.

These guidelines provide the reader with an indication of the nature of the potential impacts on the environment and the surrounding region from construction and operation of leather tanneries. In this capacity, the volume is intended to assist USEPA personnel in the identification of these impact areas that should be addressed in an EID. In addition, the guidelines present (in Chapter I) a description of the industry, its principal processes, environmental problems, and recent trends in location, raw materials, processes, pollution control, and the demand for industry output. This "Overview of the Industry" is included to familiarize USEPA staff with existing conditions in the industry.

One of the principal sources used in preparing these guidelines is the Development Document for the Leather Tanning Industry prepared by USEPA (1979). The Development Document represents an evaluation of the industry with its purpose to identify appropriate control levels for water-borne pollutants as a basis for establishing effluent limitations. The Leather Tanning Development Document was authorized by the Clean Water Act Amendments of 1977 and is recommended as an additional source of information on the leather tanning industry.

This guideline document may be transmitted to an applicant for informational purposes, but is not intended to represent the procedural requirements for obtaining an NPDES permit or to represent the applicant's total responsibilities relating to the new source EIS program. Because the content of an EID for a specific new source applicant is determined by USEPA in accordance with Section 6.908(b) of the Code of Federal Regulations, this document does not supersede any directive received by the applicant from USEPA's official responsible for implementing that regulation.

The Guidelines are divided into seven sections. Section 1.0 is the "Overview of the Industry," described above. Section 2.0, "Impact Identification," discusses process-related wastes and the impacts that may occur during construction and operation of the facility. Section 3.0, "Pollution Control," describes the technology for controlling environmental impacts. Section 4.0, "Evaluation of Available Alternatives," discusses the consideration and impact assessment of possible alternatives to the proposed action. Section 5.0 describes regulations other than pollution control that apply to the industry. Section 6.0 includes a glossary of terms relating to the leather tanning industry and the general environmental assessment disciplines. Section 7.0 presents references available for more in-depth discussions on the industry, by topic as well as in an alphabetic listing.

1.0 OVERVIEW OF THE INDUSTRY

Tanning is the process of chemically converting animal skins to leather. Archaeological evidence indicates that the Egyptians practiced tanning 5,000 years ago and that the Greeks had developed tanning into a well-established trade by 500 B.C. Tanners' guilds had been established in Europe by the 12th Century to regulate and improve the art of leather making (New England Tanners Club 1965).

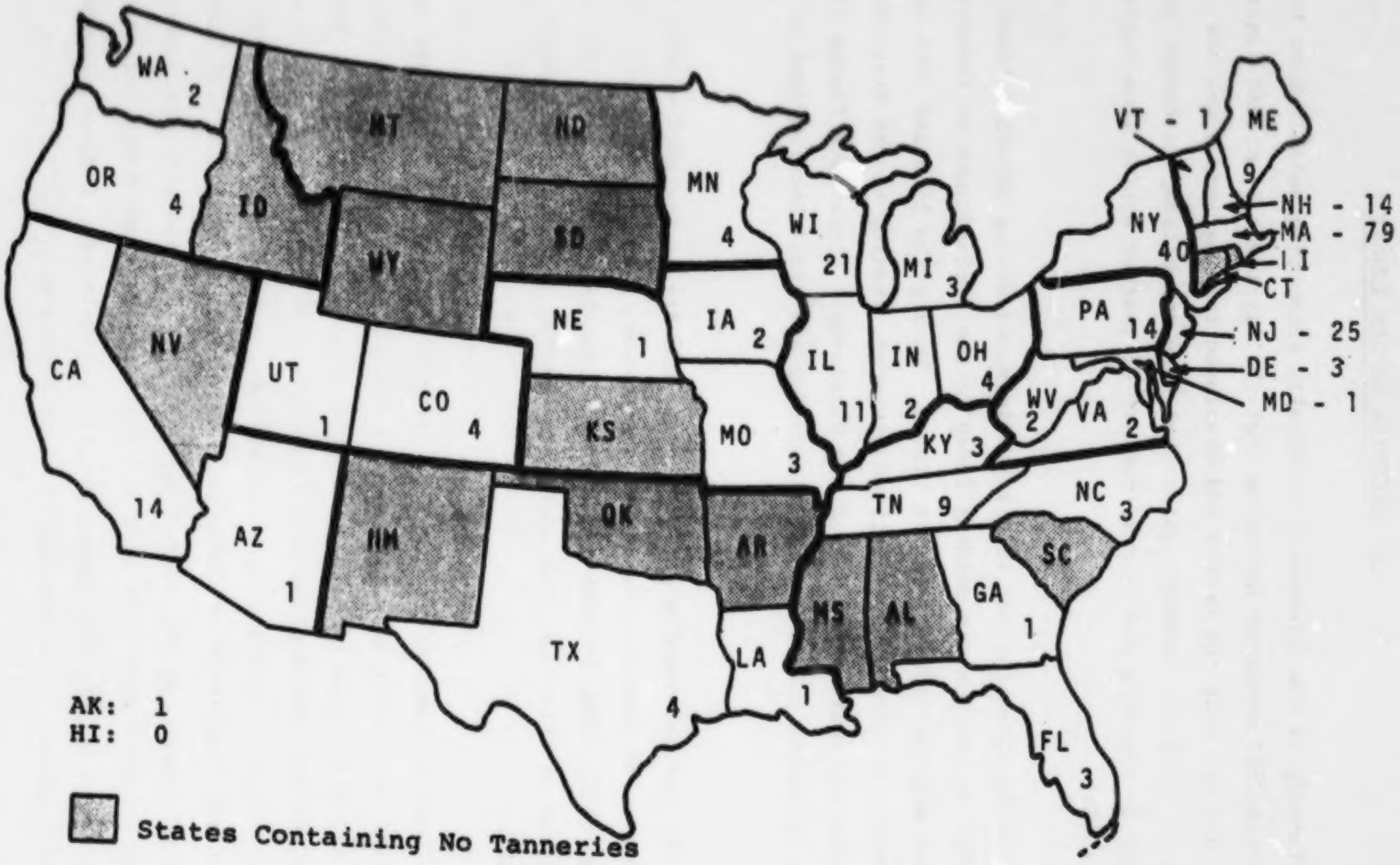
The American tanning industry originated during colonial times and its colonial beginnings are evident today in the predominance of tanneries in New England and the Middle Atlantic States. During the 19th and 20th Centuries, the source of animal hides shifted westward, leading to the distribution of some tannery operations west of the Mississippi River (see Figure 1). However, it is estimated that 85% of all tanneries are still located east of the Mississippi.

The leather tanning and finishing industry is included within the U.S. Department of Commerce, Bureau of the Census, Standard Industrial Classification (SIC) 3100, Leather and Leather Products. The part of the industry addressed in this report is identified as SIC 3111, Leather Tanning and Finishing.

"Leather Tanning" is a general term for the numerous processing steps involved in converting animal skins or hides into leather. The three major hide and skin types used to manufacture leather are cattlehides, sheepskins, and pigskins. Cattlehides constitute the bulk of the tanning performed in the United States, representing about 84% of the total estimated weight of hides tanned (US Department of Commerce 1979). Smaller quantities of hides and skins of horses, goats, deer, elk, and other animals also are tanned each year in the United States. In general, tanneries purchase hides and skins to manufacture leather for shoes, garments, upholstery, luggage, gloves, handbags, sporting goods, and a variety of other products.

Three major groups of standard processing steps are required to manufacture leather: 1) beamhouse operations which wash and soak the hides or skins and

Figure 1. Georgraphical distribution of U. S. tanneries.


WA 2
OR 4
CA 14
ID
NV
MT
WY
UT 1
AZ 1
CO 4
NM
ND
SD
NE 1
KS
OK
TX 4
MN 4
IA 2
MO 3
AR
LA 1
WI 21
IL 11
MI 3
IN 2
OH 4
KY 3
TN 9
MS
AL
GA 1
FL 3
SC
NC 3
VA 2
WV 2
PA 14
NY 40
VT - 1
ME
9
NH - 14
MA - 79
I.I
CT
NJ - 25
DE - 3
MD - 1
AK: 1
HI: 0
States Containing No Tanneries

SOURCE: SCS Engineers. 1976. Assessment of industrial hazardous waste practices - leather tanning and finishing industry.

remove the attached hair, 2) tanyard processes in which the tanning agent reacts with and stabilizes the proteinaceous matter in the hides or skins, and 3) retanning and wet finishing processes which accomplish further tanning by chemical agents such as dyes, lubricants, and various finishes.

The complexity associated with the industry is demonstrated by the process combinations. Some plants tan and finish a single species of animal hide, while others tan and finish various combinations of animal hide types. Some tanneries have a single, highly specialized end-product such as lace leather or mechanical cushions for pianos. Other tanneries produce a variety of leather types for many consumer goods and industrial uses. The variety of final products produced by the individual tannery influences the hide types required and processing operations employed by that facility. Many tanneries produce finished leather from raw, green salted, or brine cured hides; other tanneries, however, perform only a portion of the total process. Several facilities purchase previously tanned hides or splits and perform only the retan, color, fatliquor and finishing processes. A number of tanneries purchase hides and skins which either do not require a complete beamhouse process (such as pigskins) or which have previously gone through the beamhouse (such as pickled cattlehides and pickled sheepskins).

Tannery wastes can create or contribute to the following problems for Publicly Owned Treatment Works (POTW's) and separate industrial wastewater treatment facilities:

- large pieces of scrap hide and leather clogging or fouling operating equipment;
- excessive quantities of hair and other small-scale, screenable solids;
- highly acidic or alkaline waste streams;
- wastewater flow surges;
- excessive loadings of suspended and settleable solids and BOD_5, consistently or in surges;
- odors, facilities corrosion, very high dissolved oxygen demand in biological treatment system aeration basins, and hazardous gas generation from sulfide bearing wastes

- a potential future problem with disposal of sludges containing chrome; and
- pass through of ammonia nitrogen.

Each of the problems outlined, except for pass through of ammonia nitrogen, can be reduced significantly or eliminated by applying pretreatment technology in leather tanneries. Fine screening effectively removes hair, fibers, and scrap material from wastewater and is available in many different configurations, some of which are particularly effective on tannery type wastes. Screening equipment also must be installed, operated, and maintained properly to function well.

Waste streams from specific processes in tanneries can be highly acidic or alkaline. If such streams are discharged without pH adjustment or mixing with a different neutralizing stream, the waste stream may create problems within the sewer or at the treatment plant. A pH control mechanism of holding and mixing various wastes or of directly adjusting the pH of the waste is easily implemented as a pretreatment technology.

Flow and waste loading surges particularly can disrupt biological treatment systems employed by the POTW's, and they can be minimized by equalizing the rate of flow or waste loading discharge. If space limitations at a tannery preclude an equalization tank, discharge scheduling as practiced by at least one tannery can reduce the magnitude of these surges.

Catch basins, wet wells, and other preliminary treatment facilities that provide a retention time and space for solids separation from the waste stream can be very effective if properly designed and maintained. Such a facility requires regular maintenance in order to operate consistently and effectively.

Municipal problems in disposing of municipal sludge that contains chromium can be shifted largely back to the tannery. In such cases, a smaller quantity of sludge containing a higher concentration of chrome is more easily disposed in a controlled environment. Chrome recovery and reuse technology also is available and in use by the industry. This substantially reduces the chrome content of the waste stream and of sludges generated in treatment of these wastes.

The leather tanning and finishing industry characteristically is family-owned, not very progressive or profitable, and dominated by small plants employing less than 100 people. There are an estimated 188 leather tanning and finishing plants in the United States today comprised of 170 dischargers to publicly owned treatment works (indirect dischargers) and 18 direct dischargers. Total industry flow is approximately 52 million gallons daily (mgd), of which 47 mgd are discharged to POTW's and 5 mgd are discharged directly to navigable waters (USEPA 1979) .

1.1 SUBCATEGORIZATION

The raw material of the leather tanning industry is the hide or skin subjected to the processing operations. Manufacturing processes relate to the type of raw material received by the facility. For example, some tanneries process previously tanned hides or skins, thus eliminating the need for beamhouse operations. Other significant process considerations include the tanning process utilized and the presence of finishing operations, including retanning. Plant size, age, and location (including climate), as well as wastewater characteristics and treatability, represent the secondary factors of the subcategorization rationale.

The factors considered for subcategorizing the leather tanning industry include (USEPA 1979):

- Raw material (cattlehide, split, pickled sheepskin, shearling, and pigskin).
- Manufacturing processes [beamhouse operations, tanning process (chrome, vegetable, alum), and finishing operations (including retanning)].
- Plant size.
- Plant age.
- Plant location and inherent climate.
- Wastewater characteristics and treatability.

Raw material and manufacturing processes have been determined to be the most significant factors in subcategorizing the leather tanning point source category (USEPA 1979). Seven subcategories have been developed: four of the subcategories primarily cover the cattlehide to leather segment of the industry; two subcategories cover operations which have no beamhouse; and the seventh subcategory covers shearling tanning (sheepskin with hair intact).

The seven subcategories are defined as follows (USEPA 1979):

1.1.1 Hair Pulp/Chrome Tan/Retan-Wet Finish - facilities which primarily process raw or cured cattle or cattle-like hides into finished leather by chemically dissolving the hair (hair pulp); tanning with chrome; and retanning and wet finishing.

1.1.2 Hair Save/Chrome Tan/Retan-Wet Finish - facilities which primarily process raw or cured cattle or cattlelike hides into finished leather by chemically loosening and mechanically removing the hair; tanning with chrome; and retanning and wet finishing.

1.1.3 Hair Save/Non-Chrome Tan/Retan-Wet Finish - facilities which process raw or cured cattle or cattle-like hides into finished leather by chemically loosening and mechanically removing the hair; tanning with primarily vegetable tannins, alum, syntans, oils, or other chemicals; and retanning and wet finishing.

1.1.4 Retan-Wet Finish - facilities which process previously unhaired and tanned hides or splits into finished leather through retanning and wet finishing processes including coloring, fatliquoring, and mechanical conditioning.

1.1.5 No Beamhouse - facilities which process previously unhaired and pickled cattlehides, sheepskins, or pigskins into finished leather by tanning with chrome or other agents, followed by retanning and wet finishing.

1.1.6 Through-the-Blue - facilities which process raw or cured cattle or cattle-like hides into the blue tanned state only, by chemically dissolving or loosening the hair and tanning with chrome, with no retanning or wet finishing.

1.1.7 Shearling - facilities which process raw or cured sheep or sheeplike skins into finished leather by retaining the hair on the skin; tanning with chrome or other agent; and retanning and wet finishing.

1.2 PROCESSES

1.2.1 Major Processes of the Leather Tanning and Finishing Industry

Animal skin is composed of outer and inner (epidermal and dermal) layers and it is the inner (dermal) layer which constitutes the leather-making portion of the skins and hides. This dermal layer consists mainly of the protein collagen. Tanning is essentially the reaction of collagen fibers with tannin, chromium, alum, or other tanning agents which help stabilize, or preserve, the skin and make it useful.

Water is essential to leathermaking and is used in virtually all manufacturing processes. Various chemical preservatives, biocides, coloring pigments, and solvents also are integral to producing leather from animal hides or skins. The standard manufacturing processes characteristic of the industry are shown schematically in Figure 2. Each of the four major process groups (beamhouse, tan, retan, and wet finish) consists of specific subprocesses. For the purpose of this study, a manufacturing process is defined as a single step in the complete manufacturing operation where alternative steps may result in significantly different waste characteristics. A process can consist of one or a series of subprocesses. In any defined process, subprocesses remain the same. This concept of manufacturing steps seems best to allow for the variation of processes used by different plants (USEPA 1979).

The processes required at a specific tannery are dependent on the type of hide being tanned and the final projected use for the leather product. Individual tanners will vary process conditions to meet product specifications, which may result in considerable differences between the way a process is used from one tannery to another. The use of cattle, pig, or sheep skins for making leather will also require slightly different processing techniques (Section 1.2.2).

1.2.1.1 Beamhouse Operations

The beamhouse operations prepare the raw hides received from the meat packer for tanning.

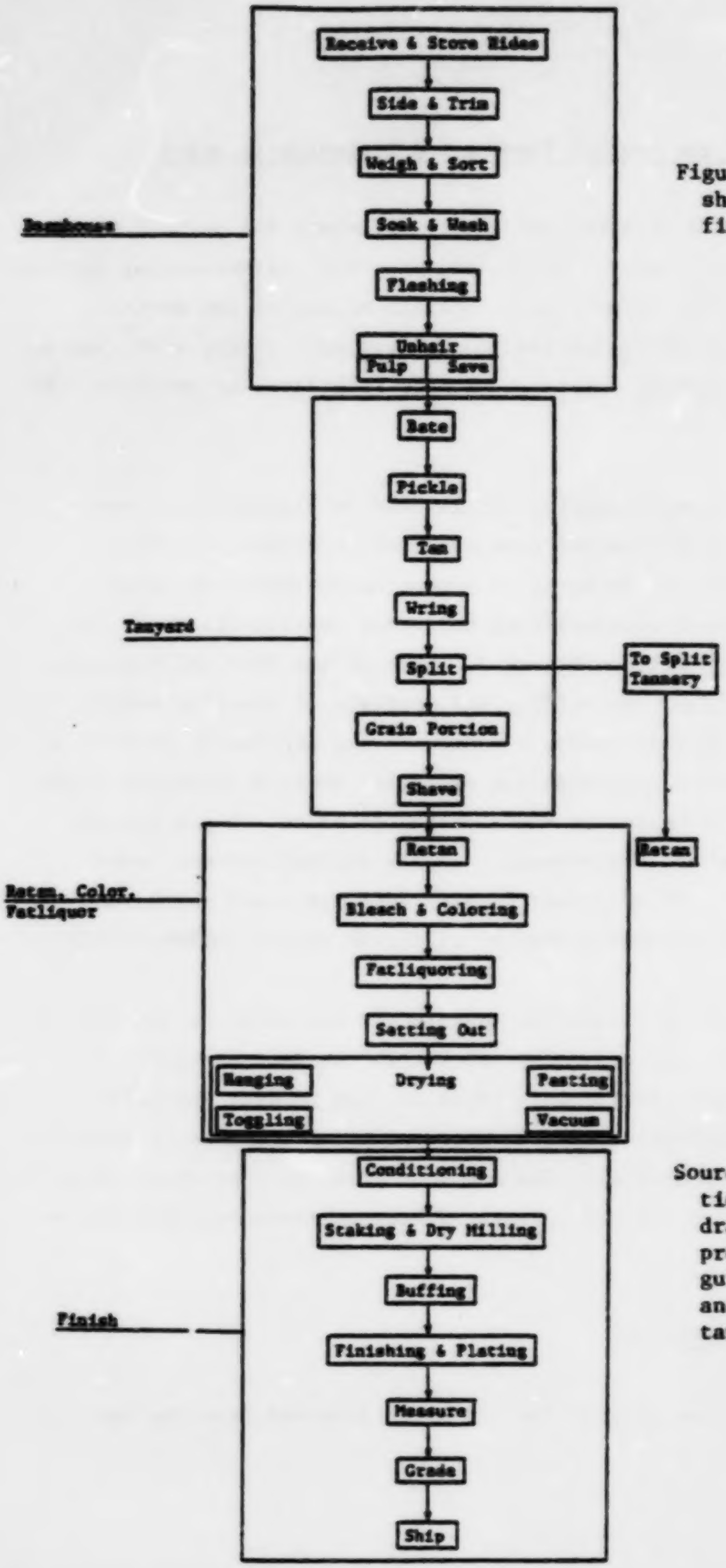

Receive & Store Hides
Side & Trim
Weigh & Sort
Soak & Wash
Fleshing
Unhair
Pulp
Save
Beamhouse
Bate
Pickle
Tan
Wring
Split
To Split Tannery
Grain Portion
Shave
Tanyard
Retan
Retan
Bleach & Coloring
Fatliquoring
Setting Out
Retan, Color, Fatliquor
Hanging
Drying
Pasting
Toggling
Vacuum
Conditioning
Staking & Dry Milling
Buffing
Finishing & Plating
Measure
Grade
Ship
Finish

Figure 2. General process flowsheet for leather tanning and finishing industry.

Source: U.S. Environmental Protection Agency. 1979. Preliminary draft development document for proposed effluent limitations guidelines and new source performance standards for the leather tanning and finishing industry.

Receiving

Most cattlehides are received at the tannery as salt or brine cured hides unless the packer is close enough to permit shipping of uncured, green hides directly to the tannery without danger of spoilage. Although the curing process is generally performed at the meat packer and is therefore more closely associated with the meat packing industry, the commonly used methods have been outlined below to indicate more clearly the types of pollutants to be expected at the tannery.

One process for salt curing involves interlayering hides flesh side up with granular salt in stacks for 10 to 30 days. The salt is gradually absorbed by diffusion and osmosis and replaces the moisture of the hides. Excess salt is removed before the hides are rebundled for shipment.

Currently, the preferred curing procedure for green hides is washing and soaking in brine. In this process, the hides are agitated in brine until the desired salt content is reached; then they are drained, given a light coating of additional salt, and bundled for shipment. The relatively short (2-3 day) curing time and the associated removal of blood, manure, and other foreign matter during the washing make this process attractive to both packer and tanner.

Trimming and Siding

The first process which usually takes place at the tannery after removing the hides from storage is trimming, to remove ragged edges and loose pieces of skin. Some cattle hides are cut in half along the backbone (sided) before further processing. The smaller skins of sheep and pig do not require siding. Trimmings are collected and sent to by-product manufacturers or rendering operations.

Washing and Soaking

Although washing may be required several times during the tanning process, the first washing is primarily intended to remove the curing salt. In addition, soaking of the hide helps restore the moisture in the hide lost during the curing process. Other contaminants such as dirt, blood, manure, and any preservatives which remain on the hide are also removed during this process, especially from salt cured or uncured hides. Hides are usually washed in vats, drums, or in a specially designed concrete mixer device called a hide processor.

Fleshing

In this operation, hides are drawn through a fleshing machine consisting of a rubber pressure roller and a set of revolving spiral blades which remove fat, connective tissue, muscle, and flesh which are left on the hide. Fleshing is generally done at the packing house or at a separate hide processing facility but sometimes is also required at the tannery. When this operation is performed before unhairing, it is referred to as green fleshing. It also may be done after tanning in the case of sheepskins, or by caustic burning during the unhairing process, in which case it is called lime fleshing. Because recovery of fleshings for rendering is common practice throughout the industry, the waste load from this operation is low. A small volume of cold water is used, however, to keep the fat congealed during the fleshing operation.

Liming and Unhairing

Hides are soaked in a lime solution and the hair is removed to improve appearances and open the fiber structure to aid penetration of tanning chemicals. This process also helps remove unwanted globular proteins from the hide structure. Due to the use of strong chemicals and the dissolution of hair and proteins, this process produces the greatest pollution load from the beamhouse. Unhairing is performed either as a chemical-mechanical process called hair-save, or by an all chemical process called hair-pulp or hair-burn. In both processes, hides are loaded into vats, drums, or hide processors with a slurry of lime and sharpening agents such as sodium sulfide, sodium sulfhydrate, or more recently, dimethylamine sulfate, which all act to improve the effectiveness of this process. The highly alkaline unhairing chemicals loosen and dissolve hair at its roots and cause hide fibers to absorb large amounts of moisture which makes the hide swell. This alkaline swelling may cause a hide to reach twice its normal thickness. The concentration of the unhairing slurry and the length of processing time vary depending on the process. The two major unhairing processes involve:

- Hair-Pulp. If hair is to be chemically dissolved or pulped, stronger solutions, higher temperatures, and/or longer processing times are used. Solubilization of the hair protein in this process produces high liquid phase pollution loads, particularly with respect to BOD, COD, sulfides, and nitrogen. The sulfide content of this wastewater is generally higher than that from the hair-save process due to the higher concentration of sharpeners. Hides and skins are sometimes relimed after unhairing to ensure complete hair removal and to ensure uniform alkaline swelling of the hides prior to beginning the tanning process.

- Hair-Save. For the hair-save process, chemical concentrations, temperatures, and processing time are limited to that necessary to loosen the hair so that it can be mechanically pulled by a machine which is similar to the fleshing machine with blunt blades. The removed hair may be washed, baled, and sold as a by-product, but markets are limited. Following mechanical removal of the hair, the hide may be reprocessed to remove fine hairs and roots by reliming the hide and running it through the unhairing machine a second time.

These unhaired hides are generally considered the product from the beamhouse and are used immediately at the tanhouse.

1.2.1.2 Tanhouse Operations

The tanhouse operations convert the hide or animal skin (from the beamhouse operations or an outside supplier) to a durable material which is not subject to physical or biological degradation.

Bating

After unhairing, a hide is swollen from the strong lime solutions. The bating process is performed to reduce swelling, lower pH, peptize the proteinaceous collagen fibers, and reopen the hide structure to allow removal of the protein degradation products. Hides are loaded into vats, drums, or hide processors with a solution of ammonium salts and enzymes. Ammonium sulfate or ammonium chloride is added to convert the residual lime to a soluble compound which can be washed out of the system. Enzymes such as trypsin are also added during the bating process to separate the collagen fibers and condition the skin. Ammonia and calcium sulfate (the result of the lime - ammonium sulfate reaction) are wastes from this process. This is one of the major sources of nitrogen wastes from tanning. The use of other bating salts, such as magnesium sulfate or magnesium chloride, is being investigated to replace these ammonium-based bating solutions (Koopman 1974). After bating, hides are thoroughly washed to remove any substances that have been loosened or dissolved.

Pickling

When the hide is to be chrome tanned, it must be acidified to prevent precipitation of insoluble chromium salts on the skin fibers. The pickling operation is not necessary when vegetable tanning is used. Pickling also is used to preserve hides if storage is necessary prior to tanning.

Hides are usually pickled for a few hours in the same vat or container used for bating. Salt is first added to the vat or hide processor to form a buffer solution and prevent acid swelling which would damage the hide. The hide is then pickled in a sulfuric acid solution for up to 12 hours. Pollutant generation from this process is relatively low, but there may be significant volumes of wastewater unless recycling is practiced.

Degreasing

Skins from sheep, goats, and pigs contain large quantities of fat and grease that must be removed prior to tanning to eliminate problems with dyeing and finishing and to allow better penetration of tanning chemicals. There are several alternative methods of degreasing:

- Emulsification. Skins are washed in a hot water and detergent solution to remove grease and oil. The grease is usually separated and recovered as a salable by-product.
- Solvent Extraction. Most pigskins are washed and soaked in hot water to raise their temperature for degreasing. Following washing, solvents are added and the skins are agitated to remove grease. The grease and solvent are separated from the wash water by decanting. Grease and solvent recovery are commonly practiced using a solvent stripping column. Recovery processes make solvent degreasing a relatively low pollution process. However, there is a small volume of wastewater and some solvent is vented directly to the atmosphere.

- Mechanical. Some sheepskins may be degreased by mechanically squeezing the grease, skin oils, and lanolin out of the skin. The grease and oil are recovered.

Tanning

Hides or skins are tanned to give them the mechanical properties of leather, such as abrasion resistance and flexibility, and to prevent them from decaying. The two main tanning agents used commercially are chromium sulfate solutions and solutions of various vegetable tannins. Alum, other metal salts, and formaldehyde are tanning agents but are not widely used on a commercial scale. Certain synthetic tanning agents (syntans) have been developed over the years, but these are used mostly as auxiliary agents to these principal tanning agents.

These different tanning agents produce leathers with various working qualities and end uses. Heavy leathers that require great durability, such as shoe soles, saddles, or belts, are usually vegetable tanned. Lighter leathers requiring greater abrasion resistance for use as garments or shoe uppers are usually chrome tanned. Leather may be tanned by one operation or it may be tanned and retanned in two different solutions to impart different qualities to the leather. The major alternatives involve:

- Vegetable Tanning. Vegetable tanning, the older of the commercially used tanning processes, takes several weeks. The hides are gently agitated in rocker vats containing a solution of vegetable extracts or they are soaked in vats containing progressively stronger solutions of tanning liquor. Vegetable tanning solutions are made of quebracho, wattle, chesnut, eucalyptus, and other vegetable extracts. With the cost of tanning chemicals and labor escalating, vegetable tanners are recycling tanning solutions by refortification and using higher concentrations of tannins to reduce processing time. Synthetic tanning agents also may be used to improve dispersion and penetration of the vegetable tanning solutions into the hide fiber. Following tanning, the leather is covered, allowed to stand for about 42 hours, and washed of excess tannins.

- Chrome Tanning. Most leathers today are chrome tanned. While they are light use leathers, they have more resistance to heat and abrasion than vegetable tanned leathers. Chrome tanning requires less than one day. Chromium atoms are believed to react with the hide proteins by bridging the space between carboxyl and amino groups on adjacent protein molecules. Tanning is generally carried out in a vat or hide processor using proprietary mixtures of basic chromium sulfate. This produces a hide at the blue tanned stage, so named due to its color. Chrome tannery wastes do not contribute high concentrations of conventional wastes such as BOD, but do contain high concentrations of dissolved solids and potentially toxic trivalent chrome. Tanning solutions are sometimes made by reducing hexavalent sodium dichromate with sulfuric acid and sucrose to produce the trivalent chrome necessary for tanning. Accidental spills are therefore the only source of the more dangerous hexavalent form of chrome which might be found in a tannery.

Wringing

Wringing removes excess moisture from the hide before it is split. This is done by feeding the hides through a machine with two large rollers similar to a clothes wringer. For plants in the through-the-blue category (Subcategory 6) this completes the processing of the hides and the wet blue stock generally is sold to another plant for the retanning and wet finishing operations. For other tanneries, the tanned hide is processed further to produce the required leather product.

Splitting

Because hides are usually too thick for most uses, the finer grade grain leather is often separated from the flesh side leather (called the split) after the initial tanning operation using a machine resembling a horizontal bandsaw. Splitting following the unhairing process (referred to as lime splitting) was once a common practice, but this is not practiced extensively today. Splits are either processed separately at the tannery or sent to another tanner who processes splits. In the case of pigskin, the split is sold to fertilizer manufacturers as a by-product since pig splits are of no use as leather. The grain portion of a hide may be shaved to remove any fleshy matter from the hide that was not removed with the splitting knife. The shaving machine is also used to level the hide to a uniform thickness.

1.2.1.3 Retanning, Coloring, and Fatliquoring

Following the initial tanning process, which is primarily for preservation of the fibers, operations are carried out to impart the desired look, feel, and working qualities specified by the customer. Hides at the blue stage are placed in drums and first treated with retan formulations, followed by dye formulations, and then by fatliquoring chemicals.

Retanning

Retanning is a second tanning step commonly used to alter the characteristics of the leather. This may involve vegetable retanning of a chrome tanned leather to give it some of the plumpness and workability of a vegetable tanned leather, or chrome or synthetic tanning of a vegetable tanned leather to give it some of the durable qualities of chrome tanned leather. It is in the retanning process that most synthetic tanning agents (syntans) are used.

Bleaching

Vegetable tanning of some leathers such as those used for shoe soles may be followed by bleaching to improve the color characteristics of the tanned leather. This is usually done immediately following the tanning process.

Coloring

Following the retanning step, leather may be adjusted to the desired color using natural or synthetic dyes. This is usually done in the same vat as retanning. These dye wastes are a concern due to the complex organic composition of some of the dye materials (e.g., analine derivatives and organometallic substances).

Fatliquoring

The final wet process for leather is to add oils and greases to the tanned hides to replace those lost during processing. This prevents cracking and makes the leather soft, pliable, strong, and tear-resistant. Fatliquoring is usually carried out by immersing the hide in an emulsion of oil and fatty substances at a temperature of 120° - 140°F for a few hours. Aliphatic mineral oils are sometimes used in small quantities for heavy industrial and shoe leathers.

1.2.1.4 Finishing

Finishing requires a series of dry operations which give leather its final attractive surface qualities. Little if any finishing is done to vegetable tanned hides; however, chrome tanned hides may be put through any of several finishing processes.

Setting Out

Setting out smooths and stretches the skin, while compressing and squeezing out excess moisture.

Drying

Drying is accomplished by four different methods:

- Hanging. The hide is draped over a horizontal shaft which is usually passed through a large drying oven.
- Toggling. The skins are dryed in a stretched position on frames. The frames are slid into channels in a drying oven.
- Pasting. The skins are pasted onto plates which are then transported into a drying oven.
- Vacuum. The hides are smoothed out on a heated steel plate and covered by a perforated belt or cloth-covered steel plate. A vacuum is pulled which extracts water from the leather. Unlike the first three processes which take four to seven hours per skin, this method requires only three to nine minutes. However, this method has limited application due to shrinkage.

Conditioning

Hides are sprayed with a water mist and then piled on a table, wrapped in a watertight cover, and kept overnight to permit uniform moisture distribution in the leather. This improves the handling characteristics of the hides during subsequent operations.

Staking and Dry Milling

Staking is done on automatic machines which stretch and flex the leather to make it soft and pliable. Dry milling consists of tumbling the hides in a large drum.

Buffing

Buffing is a light sanding operation performed on the grain or split side of leather to smooth or correct irregularities in the grain surface. Dust from this operation is the industry's most significant air pollutant.

Finishing

A number of finishes may be applied to leather by rolling or spray application depending on the end use of the leather and type of hide. Various coating materials, both water-based and solvent-based, are used to provide abrasion and stain resistance and to enhance color. Solvent-based coatings are sometimes used for high luster finishes, but their use is being reduced due to handling problems and fire hazards.

Plating

The final processing step which influences the appearance and feel of leather is plating, which is performed by pressing the leather onto a large smooth surface. This smoothes the surface of coating materials applied to the leather while bonding them firmly to the grain. The finishing and plating operations are carried out in conjuction with each other over a period of four to five days. Hides may also be embossed (stamped with a particular pattern) in conjunction with this process.

Measuring

The hide area is determined electronically and the area is stamped on the back side of the hide.

Grading

Grading determines the quality of the finished product. Leather is graded by experts for temper (the feel and relative solidity), uniformity of color and thickness, and the extent of any surface defects.

1.2.2 Process Variations for Raw Materials

Significant variations in the basic preparatory and tanning processes described here are required for the three major types of hides or skins used by the tanning industry. The major process techniques for these hides are discussed below.

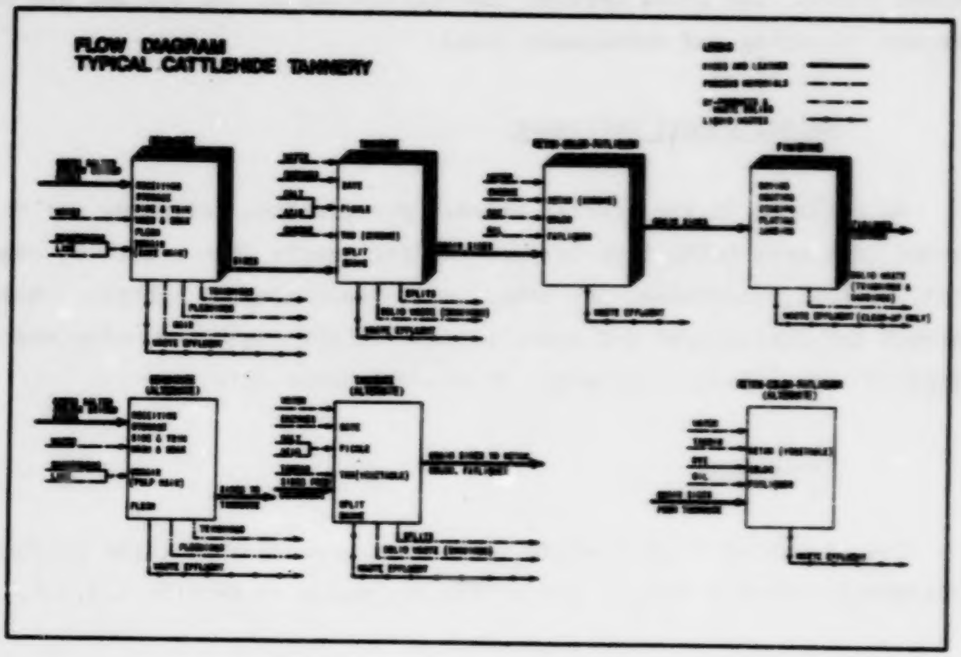
1.2.2.1 Cattle Hide Tannery

Cattle hides, which make up the vast majority of tannage in the United States, are typically processed as indicated in Figure 3.

Beamhouse

The hides are first trimmed of ragged perimeter areas and then split down the backbone (i.e., sided) in order to make manageable-sized hides for processing. As outlined in the general process description, these hides are washed, soaked, fleshed, and unhaired using either the hair save or hair pulp process. If hair is saved, it may be washed, bundled, and sold as a by-product, but the hair pulp process is currently favored by tanners due to its lower handling and labor costs.

Figure 3. Flow diagram for a typical cattlehide tannery.


FLOW DIAGRAM
TYPICAL CATTLEHIDE TANNERY
PICKLE
SPLITS
TRIMMINGS
FLESHINGS
WASTE EFFLUENT

SOURCE: U.S. Environmental Protection Agency. 1974. Development document for effluent limitations guidelines and new source performance standards for the leather tanning and finishing point source category. p. 13.

Tanhouse

Most cattle hides are tanned either by chrome or vegetable tanning processes as outlined in the general process description. The basic tanning process used for cattle hides is almost identical regardless of the end use of the leather. Hides are delimed, bated, and pickled for a few hours in an acid bath prior to tanning, although the pickling is not necessary for vegetable tanned hides. The final desired characteristics of the leather are obtained through retanning and subsequent steps.

Retan, Color, Fatliquor

As outlined in the general process description, retanning may be performed in a drum using a variety of tanning agents (i.e., chrome, vegetable, alum, syntans, zirconium, and other metal-based tanning agents). Hides may be colored and fatliquored for short periods in the same drum using analine-based dyestuffs and animal, vegetable, or mineral-based oils.

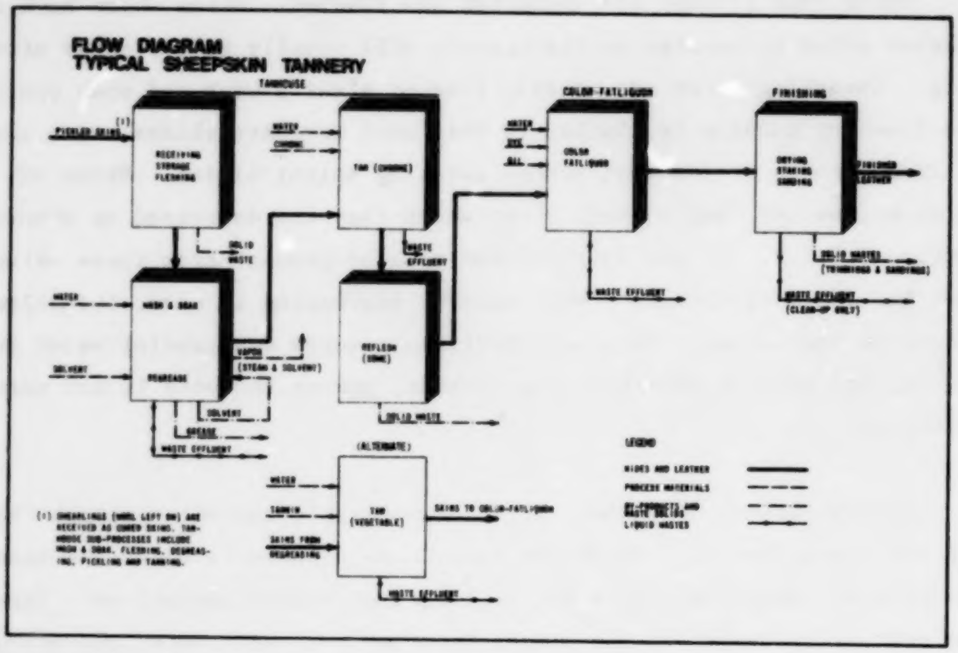
Finishing

The finishing of cattlehide leather is dependent on final product requirements, and may involve any of the processes in Section 1.2.1.4.

1.2.2.2 Sheepskin Tannery

Sheepskins are typically processed as shown in Figure 4. Most sheepskins are received at the tannery with the wool already removed, so there is essentially no beamhouse operation needed. Shearling skins, which are received with the wool still attached, are tanned to keep the wool intact and require no beamhouse operation except for fleshing. Most sheepskins are imported so they are typically received already pickled with brine and acid. Shearlings, however, are preserved in brine only.

Figure 4. Flow diagram for a typical sheepskin tannery.


FLOW DIAGRAM
TYPICAL SHEEPSKIN TANNERY
TANHOUSE
(1)
PICKLED SKINS
RECEIVING
STORAGE
FLESHING
SOLID WASTE
WATER
WASH & SOAK
SOLVENT
DEGREASE
VAPOR
(STEAM & SOLVENT)
SOLVENT
GREASE
WASTE EFFLUENT
WATER
CHROME
TAN (CHROME)
WASTE EFFLUENT
REFLESH
(SOME)
SOLID WASTE
(ALTERNATE)
WATER
TANNIN
SKINS FROM DEGREASING
TAN (VEGETABLE)
SKINS TO COLOR-FATLIQUOR
WASTE EFFLUENT
COLOR-FATLIQUOR
WATER
DYE
OIL
COLOR
FATLIQUOR
WASTE EFFLUENT
FINISHING
DRYING
STAKING
SANDING
FINISHED LEATHER
SOLID WASTES
(TRIMMINGS & SANDINGS)
WASTE EFFLUENT
(CLEAN-UP ONLY)
(1) SHEARLINGS (WOOL LEFT ON) ARE RECEIVED AS CURED SKINS. TANHOUSE SUB-PROCESSES INCLUDE WASH & SOAK, FLESHING, DEGREASING, PICKLING AND TANNING.
LEGEND
HIDES AND LEATHER
PROCESS MATERIALS
BY-PRODUCTS AND WASTE SOLIDS
LIQUID WASTES

SOURCE: U.S. Environmental Protection Agency. 1974. Development document for effluent limitations guidelines and new source performance standards for the leather tanning and finishing point source category. p. 21.

Tanhouse

No special provisions for sheepskin storage are made at most tanneries. The skins are kept moist and biocides (e.g., chlorinated phenolics) are used to retard bacterial action and increase storage time. Pickled skins held for extended periods should be kept below 30°C (86°F) to avoid deterioration.

Skins from storage are inspected and fleshed. Skins which have been fleshed prior to receipt at the tannery will usually be refleshed after tanning. Shearling hides are usually fleshed after a wash and soak operation. The fleshing machine is similar to that used for cattlehides, with the skin carried through rollers and across rotating spiral blades. Skins are placed in drums, washed, and soaked, after which they are degreased as discussed in Section 1.2.1.2. Grease is recovered as a by-product from those skins which have had the wool removed. When solvent degreasing is used, the solvent is recovered and reused. Because shearlings require substantial water in the soaking and washing (scouring) operations, grease recovery is not normally practiced.

Sheepskins may be either chrome or vegetable tanned, although the majority are chrome tanned. Where the skins have been received at the tannery in the pickled condition, there are no liming or bating operations. Skins from the degreasing operation are placed in drums with salt water and mixtures of basic chromium sulfate for chrome tanning, or solutions of the natural tannins for vegetable tanning. Shearling skins also require pickling to prepare them for the chromium tanning process.

In some cases, there is a refleshing operation following tanning, which produces a small amount of solid waste containing chrome.

Retan, Color, Fatliquor

Retanning is performed in a manner similar to the cattlehide retanning operation. Skins to be colored are immersed in a dye solution in drums. Synthetic dyes are generally used, and some bleaching may be done prior to coloring of shearlings. Fatliquoring is performed in the same drum used for coloring. Skins are immersed in a solution containing various oils to replace the natural oils of the skin lost in the tanning process.

Finishing

There are a number of operations which follow the coloring and fatliquoring process, including drying, skiving (shaving), staking, carding, clipping, sanding, and buffing. These are essentially dry processes, and the only liquid waste contributed is from cleanup operations. Solid wastes from the finishing operation include trimmings and skivings.

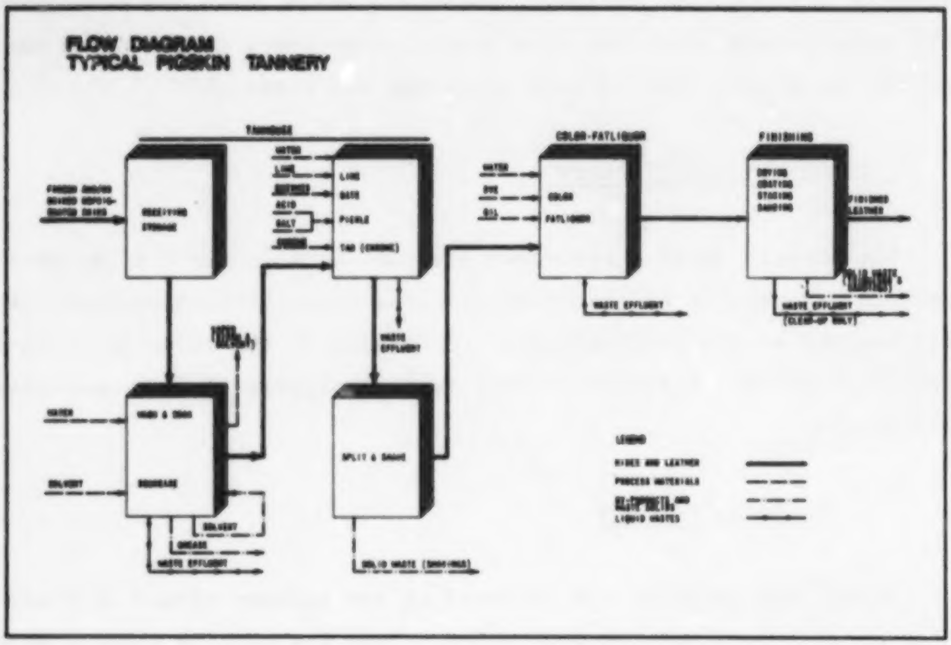
1.2.2.3 Pigskin Tannery

The pigskin tanning processes are similar to those for sheepskins in that there is essentially no beamhouse process, since most skins have the external hair removed at the packinghouse. Degreasing of the skins is a required tanhouse process. A schematic of a typical pigskin tanning operation is shown in Figure 5.

Tanhouse Process

Nearly all pigskins are received at the tannery either as fresh frozen skins or as brined refrigerated skins. They are usually tied in bundles that weigh 40 to 50 pounds. In some cases, frozen skins are received in paper bags rather than bundles. Refrigerated storage is used at most tanneries when skins are to be held before tanning. The required degreasing is usually done by the solvent method described in Section 1.2.1.2. In this process, the skins are placed in drums, then washed and soaked in warm water to bring them to a temperature suitable for degreasing. Solvent is then added and the skins are tumbled to remove the grease. The solution of solvent, grease, and water is pumped from the drums to large tanks where some separation is achieved by decanting. From the tanks the solvent and grease are sent to a stripping column where the solvent is recovered for reuse and the grease is recovered as a by-product.

Figure 5. Flow diagram for a typical pigskin tannery.


FLOW DIAGRAM
TYPICAL PIGSKIN TANNERY
RECEIVING
STORAGE
WATER
LIME
ACID
SALT
LIME
BATE
PICKLE
TAN (CHROME)
WASTE EFFLUENT
WATER
WASH & SOAK
SOLVENT
DEGREASE
SOLVENT
GREASE
WASTE EFFLUENT
SPLIT & SHAVE
SOLID WASTE (SHAVINGS)
COLOR-FATLIQUOR
WATER
DYE
OIL
COLOR
FATLIQUOR
WASTE EFFLUENT
FINISHING
DRYING
COATING
STAKING
SANDING
FINISHED LEATHER
WASTE EFFLUENT
(CLEAN-UP ONLY)
LEGEND
HIDES AND LEATHER
PROCESS MATERIALS
BY-PRODUCTS AND SOLID WASTES
LIQUID WASTES

SOURCE: U.S. Environmental Protection Agency. 1974. Development document for effluent limitations guidelines and new source performance standards for the leather tanning and finishing point source catagory. p. 24.

An alternate method, in which the skins are tumbled in hot water and detergent, has also been used. With this operation, grease is recovered by decanting or skimming from the top of holding tanks to which the waste has been diverted prior to entry into the main plant sewer system.

From the degreasing operation the skins are placed in tanning drums with a lime slurry and sharpeners, which remove the embedded portion of the hair from the skins. This is followed by bating and pickling in the same drum. While pigskin may be either chrome tanned or vegetable tanned, the only major tanner of pigskin in this country is using the chrome tanning process. Chrome tanning is conducted in the same drum used for pickling. Current practice is to fully tan the skins in this operation, eliminating any need for a retan operation at a later point.

After tanning, the skins are tumble dried and then split and shaved to obtain the desired thickness. The split portion of the pigskin has no commercial value as leather, and it is baled with other scraps and sold as a fertilizer component. The grain sides go to the color and fatliquor process.

Color, Fatliquor

Skins to be colored are immersed in a dye solution in drums, generally consisting of synthetic dyes. Fatliquoring is performed in the same drum used for coloring. The skins are immersed in a solution containing various oils to replace the natural oils of the skin lost in the tanning process.

Finishing

The operations that follow the coloring and fatliquor process include drying, coating, staking, and sanding. These are principally dry processes, and the only liquid waste contributed is from cleanup operations. Solid wastes from the finishing operations include trimmings, which are baled with the split and shave wastes and sold as fertilizer.

1.2.3 Auxiliary Support Systems

Relatively few auxiliary support systems are required by the leather tanning and finishing industry. Boilers are operated for internal heating systems and steam generation but these are not major demands. Other in-plant systems, such as solvent recovery systems for the degreasing process and evaporators for concentrating spent tanning liquor, actually serve as waste treatment and resource recovery systems.

When hide curing is done at a separate facility rather than at the meat packing plant, it may be considered a support system for the leather tanning and finishing industry. In these cases, certain other operations normally associated with the tannery, such as fleshing and washing, may also be performed. These curing and washing operations can be a significant source of pollution in the form of dissolved solids, blood, manure, and dirt, and should be clearly identified if they are to be included at the tannery.

1.3 SIGNIFICANT ENVIRONMENTAL ISSUES

1.3.1 Location

Tanneries traditionally have been relatively small operations which do not involve large numbers of employees, large volumes of water, or bulk raw material shipment, and therefore have not been of great significance on a national or regional level. However, as the trend for new facilities favors uniform production techniques and mass production, the emphasis on large facilities can be anticipated. Such facilities may result in the following local impacts:

- A tannery may involve changes in land use and result in direct and indirect social and ecological impacts.
- Significant liquid and solid phase waste loads from a tannery may overwhelm the publicly owned treatment works (POTW) and land disposal facilities of a small community if these existing systems are to be used by the industry.
- A new tannery may be a member of an industrial complex involving the processing of meat and meat by-products which could collectively have a greater impact on the community than the tannery itself.

- Secondary impacts during construction of a new tannery may be significant in smaller communities.

- Long-term trends for larger facilities (Section 1.4.1) and the existence of tannery towns indicate that income in these areas could be increased sufficiently to induce spin-off development.

1.3.2 Raw Materials

No raw materials are used in sufficient quantity to constitute a major environmental problem. Resources required at a tannery include hides; water; process chemicals such as lime, chromium, sulfides, ammonium salts, and sulfuric acid; and energy. These requirements usually will not pose a significant environmental issue if Best Management Practices are required as described by the Clean Water Act (Section 304e). Special areas of concern include:

- Dissolved solids loading in the tannery's liquid waste stream due to salt or brine cured hides.

- Trivalent chrome tanning solution production by reducing the highly toxic hexavalent sodium dichromate with acid and a carbon source.

1.3.3 Processes and Pollutants

Wastewater characteristics vary among tanneries based on such factors as type and condition of raw hide, final product, processes and process equipment used (e.g., hide processors), and tanning agent. The pollutants basically differ little from those in wastewaters of many other industries and can be treated by conventional methods for suspended solids reduction, oil and grease removal, pH control, and BOD reduction. Specific constituents peculiar to certain tanning processes, such as chromium and sulfide, can be removed with available treatment methods currently practiced by the industry.

Tannery waste treatment cannot overlook the interrelationship of the different media (i.e., air, water, and land) for pollutant discharge; for example, coagulation-sedimentation and sludge dewatering produce a waste produce for land disposal. If a chromium tanning process is used, this waste will contain trivalent chromium and care must be exercised in managing the waste disposal to prevent leachate contamination of ground or surface waters. The practice of chromium reuse or recovery within the plant should reduce the chromium content of the sludge.

The strong chemical solutions required by many of the processes and the high strength organic wastes can interact to create a wastewater including toxic substances that may inhibit biological treatment processes. Waste treatment is difficult because of hydraulic surges from batch process dumps of waste material. Furthermore, the variability of processes within the industry can result in treatment problems applicable only to a few tanneries, making these difficult to predict and possibly requiring unique solutions.

The sources and characteristics of process-oriented problems which have potentially significant environmental effects are highlighted below.

- Large quantities of wastewater may be generated containing high concentrations of salt and organics in the form of blood, manure, and dirt from the hide washing operation.
- A large volume of high pH wastewater with high alkalinity, sulfide, nitrogen, and dissolved and suspended proteinaceous matter concentrations is generated by the unhairing process.
- A low pH wastewater with high trivalent chromium concentration is generated by the chrome tanning process.
- Toxic hydrogen sulfide gas can be produced if the pH of the unhairing waste is allowed to fall below 9.0 as a result of mixing with some other process or waste stream. This is a potentially serious problem both from the standpoint of worker safety and effects on the surrounding environment.
- Process solutions from the dyeing and finishing operations contain a variety of priority pollutants other than chromium. These include organic dyes, solvents, heavy metals, chlorinated hydrocarbons, biocides, condensation products of formaldehyde, and others. The National Institute of Occupational Safety and Health has reported a striking increase in the incidence of bladder cancer among leather workers which may be related to dyes (USEPA 1978b).
- Large quantities of noxious and in some cases, hazardous, solid wastes may be generated from screenings, trimmings, and shavings.
- Noxious odors may be caused by the sulfides in the unhairing and bating processes, and from the decay of flesh, or other putrescible matter that is not quickly and properly disposed.

1.3.4 Pollution Control

Measures taken to control process pollution from the leather tanning industry constitute an entire set of processes and related environmental problems within themselves. Because of the nature of tannery wastes, it is often most effective to eliminate the pollutants at their source by process substitution or recovery, especially for the toxic or priority pollutants. In other cases, it is most effective to concentrate wastes by recycle or reuse, so that process solutions may be more efficiently used and waste products may be more easily treated and disposed. Still other processes are employed to physically, chemically, or biologically change the wastes to less hazardous or objectionable forms. Finally, treated residuals must be properly handled and disposed, especially in the instance of hazardous solid wastes. The sources and characteristics of waste treatment related problems which may potentially have significant environmental effects are highlighted below:

- Combined treatment of beamhouse and tanhouse streams require that pH levels be maintained high before biological treatment so that hydrogen sulfide will not be generated.

- Sludges from screening, coagulation/sedimentation, biological treatment, and dewatering units may contain chromium and other priority pollutants removed from process waste streams all over the plant. Care must be taken in disposing these hazardous wastes in accordance with applicable regulations. For example, chromium may be leached out of sludge by acetic acid produced by the decay of garbage in landfills (SCS Engineers 1976).

- Odors may be generated by sludge handling processes, if the sludge has not been properly stabilized prior to dewatering and disposal.

- Interstream transfer of wastes occurs in many waste treatment processes and this must be considered in the assessment of pollution control effects. Buffing dust which may contain chromium can be removed from the air waste stream, enter the liquid waste stream by wet scrubbing, and eventually appear in the solid waste stream after wastewater settling. Conventional and priority pollutants are removed from the liquid waste stream and enter the solid waste stream in the screening, sedimentation, and biological treatment steps. Waste may also enter the air stream from the liquid waste stream, as in the case of hydrogen sulfide generation.

1.4 INDUSTRY TRENDS

1.4.1 Markets and Demands

Products of the tanning and finishing industry are used to make familiar consumer goods such as shoes, belts, handbags, and garments as well as saddles, gaskets, and athletic equipment. The main raw material of the industry is cattlehides (84% of the industry's production) with much smaller numbers of sheepskins, pigskins, horsehides, and wild animal skins being used. (U.S. Department of Commerce 1979). Since hides are a by-product of the livestock/meatpacking industry, their supply is dictated by the demand for meat rather than the demand for leather. Worldwide demand for cattlehides exceeds the supply which has caused a recent escalation in the cost of raw hides and finished leather products.

Tanners also process significant numbers of tanned sheepskins, calfskins, lambskins, and pigskins, as well as other types of skins including kip (immature cattle), cabrettas, and horsehides. Production of these leather types has declined since 1960, although a trend toward removal of pigskins prior to butchering may lead to more pigskins and increased production of pigskin leather.

Beginning in the mid-1960's and continuing until 1974, the domestic leather tanning and finishing industry experienced a steady decline in the number of plants, production volume, and profits. This trend was attributed to: 1) greater foreign demand for cattlehide, which caused an increase in raw material cost, and 2) competition from foreign countries in the finished leather products market.

More recent data for 1975 and projections for 1976 production show total industry production, both in equivalent number of hides and in total dollar value, to be increasing. Cattlehide exports generally increased from 1965 to 1975. During the same period, a general increase in finished leather import dollar value was experienced; however, the dollar value of finished leather exports also increased. Finally, in 1975, leather exports exceeded leather imports as measured in dollars.

Increase in leather production, increase in dollar value of total industry production of leather, and increase in dollar value of leather for export are three indications of a viable U.S. leather tanning and finishing industry. Management and owners of tanning operations express confidence in the industry both verbally and by continuing capital investments in tanneries.

The industry's economic situation has continued to decline, despite a short-term improvement from 1974 to 1976; nevertheless, it may stabilize in the future as the demand for leather products balances relative to leather substitutes. Prospects for new plants vary among segments of the industry; entry of new plants appears likely for tanneries which can take advantage of strong demand and economies of scale.

1.4.2 Location

The geographical distribution of U.S. tanneries is shown in Figure 1. The principal areas for tanneries are in New England, the Middle Atlantic States, the Chicago-Milwaukee area, and the Pacific Coast (USEPA 1979). The distribution of tanneries has not shifted in recent times as indicated by the average age of tanneries shown below:

Age of plant	Percent of plants
Less than 10 years	1
10 to 14.9 years	1
15 to 19.9 years	3
20 to 29.9 years	4
30 to 50 years	18
Over 50 years	67
Data not available	6
Total	100

Source: SCS Engineers. 1976. Assessment of industrial hazardous waste practices, leather tanning and finishing industry.

Beginning in the mid-1960's and continuing until 1974, the domestic leather tanning and finishing industry experienced a steady decline in the number of plants (USEPA 1979). Although most tanneries are over 50 years old, the few built recently have tended to be through-the-blue operations located nearer the source of hides (SCS Engineers 1976). This reduces the need to transport unusable portions of hides great distances and also improves the tanner's control over the curing process. This also will tend to remove the beamhouse and tanhouse operations, which produce the greatest pollution load, away from traditional urban locations to areas where industry wastes can be more easily accommodated. New beamhouse/tanhouse operations of this sort have been opened in Missouri and Texas in the last few years. These new facilities also will tend to be larger than the traditional facilities, as uniform production techniques encourage mass production tanning.

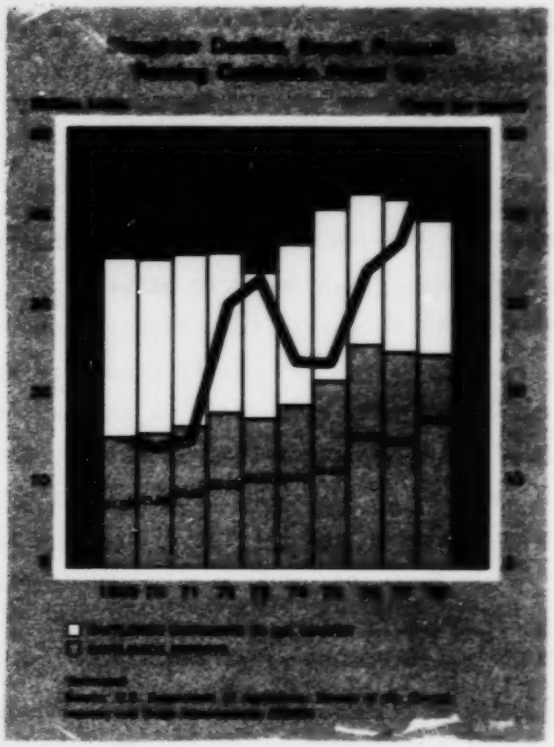
1.4.3 Raw Materials

As a by-product of the meat industry, hides and skins represent only 3 to 6 percent of the value of the live animal (USEPA 1977b). Therefore, the demand for hides will not effect their supply. During the 1960's and 1970's, there has been a rapid increase in the supply of cattlehides, which account for 84% of the hides used by U.S tanners. Due to rapid growth in the demand for meat, the cowhide supply has been steadily and rapidly increasing from 25.2 million hides in 1960 to more than 42 million in 1976. Even with the occasional production slumps which follow a cyclical pattern of building up and reducing herds, the commitment of the livestock industry to long-term growth assures the tanning industry of a continuously increasing supply of hides for the future.

Despite this expanded supply of domestically produced hides, the U.S. tanning industry has not been able to increase its production due to the price inflating effect of worldwide demand for U.S. produced cattlehides. Because total hide production has fallen from its 1976 high while exports of raw cattlehides continue to increase as a percentage of total hide production, the actual net effect has been a decrease in hides available for domestic leather production (see Figure 6).

While the supply of cattlehides has grown, the supplies of other types of animal skins have been decreasing. Calfskin supplies have been shrinking drastically in the U.S. with the exception of a temporary increase from 1974 to 1977, and are not expected to be a major factor in the market in the future (U.S. Department of Commerce 1979). Calfskin production declined 20% from 5.5

Figure 6. Trends in cost and availability of cattlehides for the U.S. market, 1969-1978.



SOURCE: U.S. Department of Commerce. 1979. U.S. industrial outlook.

million in 1977 to 4.4 million in 1978, with 2.6 million of these hides (59.1%) exported (U.S. Department of Commerce 1979). Sheep and lambskin supplies have been declining steadily over the past two decades, and the long-term prospect for sheepskins from domestic sources indicates this will continue. Domestic sheep and lambskin production declined 14% from 6.27 million skins in 1977 to 5.5 million in 1978, with 1.2 million of these skins exported. Pigskin supplies may increase, however, due to the increasing trend for removing skin before butchering. Other skin sources are not used in the United States to a great extent.

1.4.4 Processes

Identification of process trends in the leather tanning industry is complicated because tanning continues to be practiced as an art. The set of processes and procedures necessary to produce leather of the particular color, texture, and working qualities desired by customers are the guarded secrets of the trade, and there is great reluctance on the part of most tanners to make even minor changes in processes that might affect the quality of the finished product. The concern with consistent product quality and the uncertainty of most tanners on how a particular process change may affect their product make adoption of new processes quite slow and the prediction of trends quite speculative. The toxic nature of many of the industry's wastes (e.g., highly alkaline unhairing waste, chrome tanning liquor, and priority pollutant-based dyestuffs) make the most effective treatment method elimination or control at the source. For this reason, many of the process modifications which are being adopted by the leather tanning industry have as their sole or primary purpose pollution control. Those process trends primarily related to pollution control are discussed in the next section. Highlighted below are other process trends that are identified for the industry.

- Brine hide curing is currently favored over salt curing due to the reduction in time and labor involved in curing the hides and the benefits of cleaning the hides of blood, dirt, and manure before they are delivered to the tanner.
- In order to improve the efficiency of the industry, there are expected to be overall larger tanneries in the future, which will process greater numbers of hides in larger batches.

- Due to competition from synthetics, there is expected to be a continued decrease in sole leather production which is vegetable tanned. This follows a long-standing trend toward more chrome tanning and less vegetable tanning.

- Many tanneries (particularly through-the-blue operations) have adopted the use of hide processors for some or all of their wet processes. Hide processors offer an advantage in the handling of hides since washing, beamhouse, and tanhouse operations can be carried out in the same vessel.

- Hair pulp unhairing is increasing because there are few markets for by-product hair and because this process reduces fine hair carryover and requires less handling, which reduces labor costs.

- Many tanners have eliminated the solvent-based finishes used to obtain a high luster surface on leather because of the associated hazards from fire and concern for employee safety.

- Some tanners have begun to use an extremely accurate hide splitting method called "splitting to weight." It requires new equipment, but reduces the need to shave hides to obtain uniform thickness and produces a more valuable split with a lower volume of shaving waste.

1.4.5 Pollution Control

Because the leather tanning and finishing industry has traditionally been located in urban areas, many of its pollution problems have been passed on for the municipality to handle. Consequently, the job of adopting modern pollution control technology to many of the serious environmental problems of the industry has only begun in the last two decades.

1.4.5.1 In-Plant Pollution Control

As noted in the previous section, the most efficient method for eliminating pollutants from tannery wastes and in reducing the volume of effluent is through reuse of water and chemical agents and through recovery of materials which are normally wasted. The acceptance of these in-plant pollution control measures is slow, as is the case with other process trends. Typical in-plant pollution control measures currently being investigated by the industry are shown in Table 1 along with their relative degree of acceptance in a survey of 46 tanneries. The key to industry acceptance of these processes is the ability to implement them without adverse effects on leather quality. The processes most favored in this survey are highlighted below (USEPA 1979).

Table 1. In-plant process treatment indicated on questionaire from total of 46 leather tanneries.

Process Change Methods	Number of Plants Which Considered But Decided Against Process Changes	Number of Plants Which Are or Will Be Implementing Process Changes
Sulfide substitute in unhairing	17	0
Ammonium sulfate substitute in deliming	12	2*
Eliminate the bating step	12	0
Use of hide processors	14	13
Wash/soak water reuse	15	7
Lime liquor reuse	12	13
Unhairing liquor reuse	8	10
Protein recovery	6	3
Spent chrome liquor reuse	19	10
Liritan vegetable tan process	5	5
Recovery of spent vegetable tan liquor	3	8
Process or equipment wash water reuse	8	13
Cooling water reuse	4	14
Other	0	5

SOURCE: U. S. Environmental Protection Agency. 1979. Preliminary draft development document for proposed effluent limitations guidelines and new source performance standards for the leather tanning and finishing industry.

*At least one plant has abandoned this system since these data were collected for the USEPA survey.

SOURCE: Kenneth A. Dostal. 1979. Memo, Kenneth Dostal, USEPA Region V, to Bob Pickett, USEPA, Office of Environmental Review, 29 June 1979. 3 p.

- In recent years, the hide processor (modified concrete mixer) and other processing equipment have been found to be effective as a means of reducing labor, handling, and water use. The amount of new processing equipment in use is increasing, most widely for washing the incoming hides and for beamhouse operations in hair pulp processes. A few tanners also have used new equipment for the through-the-blue tanning process.

- Lime is used in large quantities in the beamhouse for opening the hide structure and for unhairing. It has been found that lime solutions can be recycled many times if solids are removed and the solution is refortified. By reducing the amount of lime in the effluent, the alkalinity of the waste and the volumes of insoluble calcium sludges generated during waste treatment are reduced.

- There are a number of vegetable tanneries that are using recycle systems to reduce the amounts of tan liquor that are discharged into the waste streams. The Liritan (Leather Industries Research Institute, South Africa) process employs such a technique by countercurrent flow of tanning solution in relation to the hides. There is little effluent, but some blowdown is necessary to prevent the build-up of contaminants in the tanning solution. One tannery recovers this blowdown tan liquor, concentrates it in a triple effect evaporator, and sells the concentrated liquor. Other tanneries use this blowdown liquor in retanning operations. However, the trend for recycle of these solutions will be limited by the availability of low cost recovery energy and a strong market for the recycled solution.

- Recycling, reuse, and recovery of chrome tanning solutions are also being practiced in the industry. During World War II, the reuse of chrome tan liquor was common practice because of the scarcity of chromium salts. Chrome tan liquor has been recycled for use as a pickle/pretan by fortifying it with acid and salt. This has also been reused for tanning by removing the solids and adding more chromium salts. Spent chrome tan liquor is also used by some tanners as a retan solution. Recovery of chrome from the waste stream is not being widely practiced.

- Large volumes of wash water are used in a tannery for equipment and process washing. Much of the water used to wash incoming hides can be reused if solids are settled or screened out, but this has been less well accepted than equipment washwater and process rinse water reuse from later steps in the tanning process.

- Waste stream segregation is being implemented by most tanners for reuse of process liquors, process solution recovery, and improved waste treatment efficiency.

The trend toward implementation of in-plant water conservation and pollution control technologies is likely to expand in the future. As chemical costs rise and regulatory requirements continue to tighten, tanners are likely to find that control of pollutants at their source, especially toxic and small volume organics, is easier and less expensive than their removal from the entire process waste stream.

1.4.5.2 End-of-Pipe Pollution Control

Pretreatment

The need for pretreatment is based on the following factors:

- Pollutants that are not removed by the publicly owned treatment works (POTW) must be removed by pretreatment.
- Pollutants that may cause treatment system upsets or hazards, collection system obstructions, or may be hazardous (e.g., sulfides) must be removed by pretreatment.
- NPDES permit control requirements imposed upon the POTW may reflect stringent water quality criteria.
- The load to the POTW secondary treatment units may need to be reduced.
- Pollutants must be removed that would render the POTW sludge unfit for reuse or disposal.

It is estimated that 90% of the tanners (who generate 75% of the leather tanning and finishing industry's wastewater) discharge to municipal sewer systems (USEPA 1979). Of that number, 12% provide no pretreatment, 20% provide coarse screening only, and 68% provide some additional pretreatment.

Many of the leather tanning industry's wastes are of such character or concentration that they require pretreatment as discussed above. As regulations for pretreatment of the industry's wastes become progressively more stringent, new tanneries discharging to municipal waste treatment systems will be required to implement progressively more sophisticated pretreatment measures. Future pretreatment technology includes practically all of the viable treatment methods that have been examined for the leather tanning industry (see Section 3.2). It is anticipated that the net effect of these stringent pretreatment requirements will be that new tanneries will find it increasingly attractive to construct and operate direct discharge waste treatment systems rather than pay for both sophisticated pretreatment and a municipal sewer charge.

Secondary and Advanced Treatment

Only 10% of existing tanneries have a direct discharge of wastewater. All of these tanneries provide some form of biological treatment as indicated below, but current and proposed regulatory requirements undoubtedly will require a substantial upgrading of the industry's waste treatment technology, since this generally has been found inadequate.

Current level of waste treatment technology among discharging tanneries

	%
No preliminary treatment	0
Preliminary treatment only	0
Secondary treatment	100
Lagoon or other treatment	72
Activated sludge treatment	28
Physical/Chemical	Plant Closed

Source: U.S. Environmental Protection Agency. 1979. Preliminary draft development document for proposed effluent limitations guidelines and new source performance standards for the leather tanning and finishing industry.

Because of the increasingly stringent limitations on industrial effluents, the specific trends will include a move away from lagoons to more reliable biological treatment in the form of extended aeration or activated sludge. Upgrading biological treatment (e.g., powdered activated carbon addition) and filtration of the final effluent also will become more common.

Solid Waste Handling and Disposal

Large volumes of potentially hazardous solid wastes are generated by the tanning industry. Treatment and disposal of these hazardous materials have not generally been handled properly by the industry in the past. For example, it is estimated that only 6% of the chrome waste generated by the industry in 1974 was disposed in certified hazardous waste disposal sites, while the remainder was disposed in a variety of landfills, lagoons, pits, ponds, and trenches. With the adoption of strict national hazardous waste regulations, the industry will be forced either to reduce its hazardous waste load or find adequate disposal sites (SCS Engineers 1976).

1.5 POLLUTION CONTROL REGULATIONS

1.5.1 Air Pollution

The leather tanning and finishing industry generally is not considered a major source of air pollutant emissions. Therefore, there are no national air pollution performance standards which apply to atmospheric emissions from new source leather tanning and finishing facilities. In the absence of Federal emission standards for the industry, air quality impacts are assessed based on ambient air quality standards, and applicable state and local standards.

National Ambient Air Quality Standards (NAAQS) (40 CFR 50) that specify the ambient air quality that must be maintained in the United States are shown in Table 2. Standards designated as primary are those necessary to protect the public health with an adequate margin of safety, and secondary standards are those necessary to protect the public welfare from any known or anticipated adverse effects of air pollution.

A combined Federal/state regulatory program is designed to achieve the objectives of the Clean Air Act and NAAQS. Each state must adopt and submit to USEPA a State Implementation Plan (SIP) for maintaining and enforcing primary and secondary air quality standards in Air Quality Control Regions. USEPA either approves the state's SIP or proposes and implements an alternate plan. The SIP's contain emission limits which may vary within a state due to local factors such as concentrations of industry and population. Because SIP's have been subject to frequent revision, it is best to verify the status of the SIP requirements before applying them.

There are two alternate programs requiring preconstruction approval of industrial air pollution abatement systems. These are the Prevention of Significant Deterioration (PSD) Program which applies to areas in compliance with NAAQS and the Nonattainment Program for areas which are in violation of NAAQS. In 1974, USEPA issued regulations for the PSD Program under the 1970

Table 2. Applicable Federal ambient air quality standards.

Emission	Primary Standard*	Secondary Standard*
Sulfur dioxide	80 $\mu g/m^3$ annual arithmetic mean	1,300 $\mu g/m^3$ maximum 3-hour concentration
	365 $\mu g/m^3$ maximum 24-hour concentration	
Particulate matter	75 $\mu g/m^3$ annual geometric mean	150 $\mu g/m^3$ maximum 24-hour concentration
	260 $\mu g/m^3$ maximum 24-hour concentration	60 $\mu g/m^3$ annual geometric mean as guide in assessing implementation plans
Nitrogen dioxide**	100 $\mu g/m^3$ annual arithmetic mean	100 $\mu g/m^3$ annual arithmetic mean
Ozone***	240 $\mu g/m^3$ maximum 1-hour concentration	240 $\mu g/m^3$ maximum 1-hour concentration
Carbon monoxide	10 mg/m^3 (9 ppm) maximum 8-hour concentration	10 mg/m^3 (9 ppm) maximum 8-hour concentration
	40 mg/m^3 (35 ppm) maximum 1-hour concentration	40 mg/m^3 (35 ppm) maximum 1-hour concentration
Lead	1.5 $\mu g/m^3$ (3-month average)	1.5 $\mu g/m^3$ (3-month average)

* For any standard other than annual, the maximum allowable concentration may be exceeded for the prescribed period once each year.

** Within one year after the date of the enactment of the Clean Air Act Amendments of 1977 (PL 95-95), the USEPA Administrator shall promulgate a national primary ambient air quality standard for NO_2 concentrations over a period of not more than 3 hours unless, based on the criteria issued under Section 108(c), he finds that there is no significant evidence that such a standard for such a period is requisite to protect public health.

*** For ozone the maximum allowable concentration may be exceeded one day each year, but on that day it may exceed the maximum hourly concentration more than once.

SOURCE: 40 CFR 50.

version of the Clean Air Act (Public Law 90-604). These regulations established a plan for protecting areas that possess air quality which is cleaner than the National Ambient Air Quality Standards. The PSD Program components include:

- a classification system for areas of the country meeting NAAQS;
- limitations on the increase in concentration of pollutants above baseline conditions;
- Best Available Control Technology requirement for large sources; and
- preconstruction review and approval by permit of new source air pollution facility abatement programs.

Under USEPA's PSD regulatory plan, all areas of the nation are designated as one of three classes. The plan permits specified numerical increments of air pollution increases from major stationary sources for each class, up to a level considered to be significant for that area (Table 3). Class I provides extraordinary protection from air quality deterioration and permits only minor increases in air pollution levels. Under this concept, virtually any increase in air pollution in these pristine areas is considered significant. Class II increments permit increases in air pollution levels that would accompany well-controlled growth. Class III increments permit increases in air pollution levels up to the NAAQS.

Sections 160 - 169 were added to the Act by the Clean Air Act Amendments of 1977. These Amendments adopted the basic concept of the above administratively developed procedure of allowing incremental increases in air pollutants by class. Through these Amendments, Congress also provided a mechanism to apply a practical adverse impact test which did not exist in the USEPA regulations previously.

The PSD requirements of 1974 apply only to two pollutants: total suspended particulates (TSP) and sulfur dioxide (SO_2). However, Section 166 requires USEPA to promulgate PSD regulations by 7 August 1980 which address nitrogen oxides, hydrocarbons, carbon monoxide, and photochemical oxidants, including use of increments or other effective control strategies. For these additional pollutants, states may adopt non-increment control strategies

Table 3. PSD increments: maximum allowable increase by class.

Pollutant*	Class I ($\mu g/m^3$)	Class II ($\mu g/m^3$)	Class III ($\mu g/m^3$)
Particulate Matter:			
Annual geometric mean	5	19	37
24-hour maximum	10	37	75
Sulfur dioxide:			
Annual arithmetic mean	2	20	40
24-hour maximum	5**	91	182
3-hour maximum	25**	512	700

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* Other pollutants for which PSD regulations will be promulgated are to include hydrocarbons, carbon monoxide, photochemical oxidants, and nitrogen oxides.

** A variance may be allowed to exceed each of these increments on 18 days per year, subject to limiting 24-hour increments of 36 $\mu g/m^3$ for low terrain and 62 $\mu g/m^3$ for high terrain and 3-hour increments of 130 $\mu g/m^3$ for low terrain and 221 $\mu g/m^3$ for high terrain. To obtain such a variance both state and Federal approval is required.

SOURCE: Public Law 95-95. 1977. Clean Air Act Amendments of 1977, Part C, Subpart 1, Section 163.

which, if taken as a whole, accomplish the purposes of PSD policy set forth in Section 160.

The 1977 Amendments designate certain Federal lands as Class I, including all international parks, national memorial parks, and national wilderness areas which exceed 5,000 acres, and national parks which exceed 6,000 acres. This constitutes 158 areas which may not be redesignated to another class through state or administrative action. The remaining areas of the country have been initially designated Class II. Within this Class II category, certain Federal lands over 10,000 acres (national primitive areas, national wild and scenic rivers, national wildlife refuges, national seashores and lakeshores, and new national park and wilderness areas) established after 7 August 1977 will be Class II "floor areas" ineligible for redesignation to Class III.

The general redesignation responsibility lies with the states. The Federal land manager has an advisory role for redesignation to the appropriate state and to Congress. Redesignation by Congress will require the normal legislative process of committee hearings, floor debate, and action. In order for a state to redesignate areas, the detailed process (outlined in Section 164(b) of the 1977 Amendments) would include an analysis of the health, environmental, economic, social, and energy effects of the proposed redesignation which would be discussed at a public hearing.

In theory, all new source tanneries would be subject to complete PSD review if they obtain their air quality permits after March 1, 1978, commence construction after March 19, 1978, or have potential (before treatment) emissions in excess of 250 tons/year of certain pollutants. Full PSD review requires analysis of effect on air quality increments, application of Best Available Technology, and a comprehensive monitoring program. In practice, however, small sources of the designated air pollutants (less than 50 tons/year, 1000 lbs/day, or 100 lbs/hour after abatement) are required only to apply for and obtain a preconstruction permit unless they would impact a Class I area. Therefore most new source tanneries should not have to go through the whole PSD review. A similar type of exemption exists for small sources (less than 50 tons/year after abatement) in non-attainment areas unless the pollutant emitted is the cause for non-attainment. In that case, a permit would be issued only after controls (offsets) were obtained by the new source from existing emission sources sufficient to effect a net reduction of the non-attainment pollutant.

1.5.2 Water Pollution

The Federal Water Pollution Control Act (FWPCA) Amendments of 1972 established two major, interrelated procedures for controlling industrial effluents from new sources, and specifically included tanneries and related facilities in the list of affected source categories. The principal mechanism for discharge regulation is the National Pollutant Discharge Elimination System (NPDES) permit. The other provision is the New Source Performance Standard (NSPS). The Clean Water Act of 1977 (P.L. 95-217), which amends P.L. 92-500, made no change in these basic procedures.

The NPDES permit, authorized by Section 402 of FWPCA, prescribes the conditions under which effluents may be discharged to surface waters. Issuance of a New Source NPDES permit is considered a significant Federal action and is subject to the requirements of the National Environmental Policy Act (NEPA). The conditions applicable to new or expanded tanneries will be in accordance with NSPS, adopted by USEPA pursuant to Section 306, and pretreatment standards promulgated to implement Section 307(b). Different standards will be applicable nationwide depending on the subcategory of tannery under consideration. Stricter effluent limitations may be applied on a site-specific basis if required to achieve water quality standards.

On 9 April 1974, USEPA published regulations specifying guidelines and New Source Performance Standards for the Leather Tanning and Finishing Point Source Category which were to become effective on 4 June 1974 (40 CFR 425: 39 FR 15696). However, these regulations were remanded and USEPA is in the process of developing new regulations for the industry which have been proposed on 2 July 1979.

The basis for New Source Performance Standards (NSPS) under Section 306 of the Act is the best available demonstrated control technology (BADCT). New plants have the opportunity to design the best and most efficient leather tanning processes and wastewater treatment technologies and, therefore, Congress directed USEPA to consider the best demonstrated process changes, in-plant controls, and end-of-pipe treatment technologies which reduce pollution to the maximum extent feasible. The effluent limitations established for new sources in each of the seven subcategories of the industry are shown in Table 4. It might be noted that since removal of toxic pollutants is of major concern in the leather tanning and finishing industry, the effluent limitations for BAT (Best Available Technology Economically Achievable), which must be attained by all existing tanneries by 1 July 1984, are the same as NSPS.

New sources that discharge wastewater to publicly owned treatment works (POTW) are required to comply with USEPA's pretreatment regulations, issued in the 26 June 1978, Federal Register (40 CFR 403). These regulations stipulate that certain POTW's, categorized by size and influent characteristics, develop POTW Pretreatment Programs. These programs are intended to prevent the introduction of pollutants by industrial users that would interfere with the operation of treatment works, would pass through treatment works, or would adversely affect opportunities to recycle and reclaim wastewaters and sludges.

Regardless of specific limitations required by the Pretreatment Programs, the regulations (Section 403.5) state that the following may not be introduced into a POTW:

- pollutants which create a fire or explosion hazard in the POTW;
- pollutants which will cause corrosive structural damage to the POTW, but in no case discharges with pH lower than 5.0, unless the works is specifically designed to accomodate such discharges;
- solid or viscous pollutants in amounts which cause obstruction to the flow in sewers, or other interference with the operation of the POTW; and
- any pollutant, including oxygen-demanding pollutants, released in a discharge of such volume or strength as to cause interference in the POTW.

In addition, there is a restriction on thermal discharges that becomes effective in June 1981.

Table 4. Proposed new source performance standards (NSPS) and pretreatment standards for new sources (PSNS) for the seven subcategories of the leather tanning and finishing industry.

Subcategory	Maximum pollutant discharge for any one day, kg/1000 kg (lb/1000 lb) of raw material										Average for thirty consecutive days not to be exceeded, kg/1000 kg (lb/1000 lb) of raw material									
	BOD_5	COD	TSS	Oil & Grease	Total Chrome	TKN	Ammonia	Phenol	Sulfide	pH	BOD_5	COD	TSS	Oil & Grease	Total Chrome	TKN	Ammonia	Phenol	Sulfide	pH
1 Hair Pulp, Chrome Tan, Retan - Wet Finish	2.1	9.5	2.5	0.91	0.053	2.3	0.77	0.015	0.0	6-9	0.61	5.8	0.70	0.26	0.015	0.66	0.22	0.0043	0.0	6-9
2 Hair Save, Chrome Tan, Retan - Wet Finish	2.3	10.0	2.6	1.0	0.053	2.4	0.81	0.016	0.0	6-9	0.65	6.2	0.74	0.28	0.015	0.69	0.23	0.0046	0.0	6-9
3 Hair Save, Non-Chrome Tan, Retan - Wet Finish	1.6	7.3	1.9	0.70	0.039	1.8	0.60	0.012	0.0	6-9	0.47	4.5	0.54	0.20	0.011	0.51	0.17	0.0034	0.0	6-9
4 Retan - Wet Finish	0.81	3.5	0.91	0.35	0.018	0.84	0.28	0.0056	0.0	6-9	0.23	2.2	0.26	0.10	0.005	0.24	0.081	0.0016	0.0	6-9
5 No Beamhouse	1.4	6.2	1.6	0.60	0.034	1.5	0.49	0.010	0.0	6-9	0.40	3.8	0.46	0.17	0.0096	0.43	0.14	0.0029	0.0	6-9
6 Through-the-Blue	1.5	6.8	1.8	0.67	0.035	1.6	0.56	0.011	0.0	6-9	0.44	4.2	0.50	0.19	0.010	0.47	0.16	0.0031	0.0	6-9
7 Shearling	6.7	29.8	7.7	2.9	0.16	7.4	2.4	0.049	0.0	6-9	1.9	18.0	2.2	0.83	0.046	2.1	0.69	0.014	0.0	6-9

Source: U. S. Environmental Protection Agency. 1979. Preliminary draft development document for proposed effluent limitations guidelines and new source performance standards for the leather tanning and finishing industry.

Among the pollutants in the raw waste from tanneries, BOD_5, TSS, oil and grease, total chromium, sulfide, ammonia, and other toxic priority pollutants are present in sufficient concentrations to represent potential problems of pollutant pass-through or sludge disposal at the POTW. Due to this, Pretreatment Standards for New Sources (PSNS) have been developed in the development document which will require removal of toxics and will regulate all of the same pollutants as covered by BAT and NSPS. Since the level of technology required to achieve PSNS and NSPS will be the same, it is anticipated that new tanneries will be encouraged to treat their own wastes subject to NSPS and obtain an NPDES permit for discharge directly to surface waters. The PSNS concentration limitations for all subcategories are listed below and the production-based mass limitations for each subcategory are identical to those listed in Table 4.

PSNS Concentration Limits Proposed for Leather Tanning (All Subcategories)

	Maximum any one day (mg/1)	Average for 30 consecutive days (mg/1)
BOD_5	70	20
COD	320	195
TSS	90	25
Oil and Grease	35	10
Total Chromium	2.0	0.5
TKN	70	20
Ammonia	35	10
Phenol	1.0	0.25
Sulfide	0.0	--
pH	Within the range of 6.0 to 9.0 at all times.	

SOURCE: U.S. Environmental Protection Agency. 1979. Preliminary draft development document for proposed effluent limitations guidelines and new source performance standards for the leather tanning and finishing industry.

Since new sources discharging to POTW's do not require NPDES permits, they are not subject to NEPA under Section 511(c)(1) of the Federal Water Pollution Control Act, as amended by the Clean Water Act of 1977.

NPDES permits also impose special conditions beyond the effluent limitations stipulated, such as schedules of compliance and treatment standards. Once tanneries are constructed in conformance with all applicable standards of performance, however, they are relieved by Section 306(d) from meeting any more stringent standards of performance for 10 years or during the period of depreciation or amortization, whichever ends first. This guarantee does not extend, however, to toxic effluent standards adopted under Section 307(a), which can be added to the NPDES permit when they are promulgated. USEPA proposes to control the discharge of toxics from the leather tanning and finishing industry by regulating two toxic pollutants used as indicator pollutants: phenol and chromium. USEPA has found that the treatment technology required to remove phenol and chromium as well as conventional and non-conventional pollutants also effectively controls the other priority toxic pollutants found in tannery waste. Therefore, the effectiveness of toxic pollutant control can be assessed by the monitoring of these indicator pollutants without the expense and technical difficulties with analysis for many of the complex organic toxic pollutants.

As encouraged by P.L. 92-500, many states have qualified to administer their own NPDES permit programs. The major difference in obtaining an NPDES permit through approved state programs rather than the Federal NPDES permit program is that the Act does not extend the NEPA environmental impact assessment requirements to state programs. However, over 50 percent of the states have enacted NEPA-type legislation and it is likely that new tanneries or major expansions of existing tanneries will come under increased environmental review. Because the scope of the implementing regulations varies considerably, current information on prevailing requirements should be obtained early in the planning process from the permitting authority in the appropriate jurisdiction.

1.5.2.1 Best Available Technology (BAT)

The effluent limitations which must be achieved by July 1, 1984 for existing facilities are not based on an average of the best performance within an industrial category. Instead, they are based on the very best control and treatment technology employed by a specific point source within the industrial category or subcategory, or by another industry whose technology is readily transferable. The analysis of control measures and practices to eliminate the discharge of pollutants also must consider the cost of such measures. BAT emphasizes in-process controls as well as end-of-pipe treatment improvements. Other considerations include: manufacturing processes; age and size of facilities; location of manufacturing facilities; process changes; engineering aspects of control technologies; cost of technology to achieve control levels; and non-water quality environmental impacts, including energy.

BAT technology uses BPT technology as a basis for further improvements. This includes primary coagulation-sedimentation and high solids extended aeration-activated sludge system with nitrification. Additional technologies for BAT include:

- In-Plant Control and Preliminary Treatment
  Water conservation and reuse to reduce flow
  Stream segregation for preliminary treatment
  Ammonia substitution in deliming
  Chrome recovery and reuse
  Sulfide liquor reuse followed by catalytic oxidation of residual sulfide
  Fine screening of segregated streams
  Flue gas carbonation and sedimentation for beamhouse wastewaters

- End-of-Pipe Treatment
  Addition of powdered activated carbon (PAC) to upgrade extended aeration-activated sludge
  Multimedia filtration
  Granular activated carbon columns
  Physical/chemical treatment (Chappel Process)

The anticipated performance associated with these technologies is included in the Development Document for this industry (USEPA 1979).

1.5.2.2 New Source Performance Standards (NSPS)

The basis for NSPS is the best available demonstrated control technology (BADCT). New plants have the opportunity to design the best and most efficient leather tanning processes and wastewater treatment technologies. A major difference between NSPS and BAT is that the evaluation of NSPS does not consider cost. For the Leather Tanning and Finishing Industry, the effluent limits for NSPS are identical to BAT.

1.5.2.3 Regulated Pollutants

The BAT and NSPS effluent limitations proposed for the leather tanning industry focus on three major groups of pollutants (USEPA 1979):

- Indicator pollutants. The difficulties of toxic pollutant analyses have prompted USEPA to propose a new method of regulating selected toxic pollutants. Historical data and inexpensive analytical methods are limited for certain toxic pollutants. Therefore, USEPA is proposing numerical limitations on "indicator" pollutants; these include BOD_5, COD, TSS, oil and grease, TKN, ammonia, sulfides, total chromium, and total phenol. The data available to USEPA revealed that when these indicator pollutants were controlled, the concentrations of toxic pollutants were significantly lower than when indicator pollutants were present in high concentrations.
- Non-toxic, non-conventional pollutants. The non-toxic non-conventional pollutants limited by BAT and NSPS include total Kjeldahl nitrogen (TKN), ammonia, and sulfide. These pollutants serve as "indicator" pollutants for the removal of toxic pollutants. These pollutants are subject to numerical limitations expressed in lbs per 1000 lbs of raw material.
- Toxic pollutants. The toxic pollutants expressly controlled for direct dischargers in each subcategory are phenol and chromium, which are subject to numerical limitations expressed in lbs per 1000 lbs of raw material. Since USEPA has adopted the control of "indicator" pollutants as the basis for controlling toxic pollutants other than chromium and phenol, no effluent limitations are recommended for any toxic pollutants other than chromium and phenol. At the same time, USEPA also is considering the possibility of establishing numerical limitations (either in concentration or mass units) for the following toxic pollutants: phenol (by GC/MS methods), 100 μg/l; 2,4,6-trichlorophenol, 50 μg/l; pentachlorophenol, 25 μg/l; lead, 250 μg/l; zinc, 250 μg/l; cyanide, 500 μg/l.

1.5.2.4 Pretreatment Standards for New Sources (PSNS)

The effluent limitations that must be achieved by new sources in the leather tanning and finishing industry that discharge into a POTW are termed pretreatment standards for new sources (PSNS). Section 307(b) of the Act requires USEPA to promulgate pretreatment standards to prevent the discharge of pollutants which pass through, interfere with, or are otherwise incompatible with the operation of publicly owned treatment works (POTW). The Act also requires pretreatment for pollutants, such as heavy metals, that limit POTW sludge management alternatives, including the beneficial use of sludges on agricultural lands. The pretreatment standards are to be technology-based, analogous to the best available technology for removal of toxic pollutants. The considerations in developing PSNS are the same as those enumerated for BAT (Section 1.5.2.1).

The candidate control technologies for meeting PSNS include (USEPA 1979):

- Water conservation and reuse to reduce flow.
- Stream segregation for preliminary treatment.
- Ammonia substitution in deliming.
- Chrome recovery and reuse.
- Sulfide liquor reuse followed by catalytic oxidation of residual sulfide.
- Fine screening of segregated streams.
- Flue gas carbonation and sedimentation for beamhouse wastewaters.
- Equalization of combined streams followed by primary coagulation-sedimentation.
- Activated sludge (high solids extended aeration with nitrification).
- Powdered activated carbon (PAC) addition to upgrade extended aeration-activated sludge.
- Media filtration.
- Physical/chemical treatment (Chappel Process).

These PSNS technologies essentially are identical to BAT because pass through of toxics in the POTW and presence of toxics in the POTW sludges may still be of concern. This requirement will encourage new facilities to treat wastewaters subject to NSPS for direct discharge.

1.5.2.5 Best Conventional Pollutant Control Technology (BCT)

BCT was established for existing industrial point sources that discharge conventional pollutants. BCT is not an additional limitation but replaced BAT for the control of conventional pollutants. However, BAT still applies for all nonconventional and toxic pollutants. The limitations established by BCT must consider the cost reasonableness of conventional pollutant reduction by the industry versus reduction by the POTW. Conventional pollutants have been defined to include BOD, TSS, fecal coliform, and pH, with COD, oil and grease, and phosphorus also proposed by USEPA as conventional pollutants (USEPA 1979). For this industry, USEPA is proposing that the conventional "indicator" pollutants (i.e., BOD, COD, TSS, oil and grease) be considered instead as toxic pollutants and therefore be regulated by BAT so that the cost reasonableness test would not apply. This definition would be applicable unless the industry can prove that the toxics, for which these conventional pollutants serve as indicators, are not present in the wastewater.

The BCT cost test was applied to proposed removal of conventional pollutants associated with BAT technology required for toxic pollutant control (USEPA 1979). The conclusion from applying this test was that effluent limits for conventional pollutants using BAT technology also meet the BCT cost test. Therefore, the BCT effluent limits for conventional pollutants (i.e., BOD, TSS, pH, COD, oil and grease) and associated control technology are the same as those determined for the BAT regulation (USEPA 1979).

1.5.3. Solid Wastes

A major part of tannery waste treatment involves the handling and disposal of the semi-solid sludges obtained from liquid treatment processes. The most predominant methods of ultimate disposal of tannery waste sludges include sludge lagoons, landfills, dumps, and spreading on the land (USEPA 1979).

Some attempts have been made to dewater sludges prior to ultimate disposal, with varying success. The three principal dewatering techniques include centrifugation, vacuum filtration, and pressure filtration. Centrifuges have appeared to meet with less success than vacuum filters or pressure filters. Reducing the moisture content of sludge by spreading on drying beds also has been successful in some areas. This is particularly attractive to smaller facilities where land area is available (USEPA 1979).

Conditioning and stabilizing a mixed domestic and tannery sludge using heat treatment processes has been employed where about 80% of the waste flow is tannery waste. Such heat treatment or similar sludge destruction process provides a stable end product from a biological standpoint. These stabilized sludges can then be incorporated into a landfill or spread on the land. One of the principal difficulties with tannery waste is the chromium content in sludges and the potential toxic impact of this metal on the environment. In testing a heat-treated alkaline sludge, it has been indicated that some of the trivalent chromium may be oxidized to the hexavalent form. Apparently, the trivalent chromium is converted through the high temperature, high pressure, high pH, and the oxidizing environment of the heat treatment process (USEPA 1979).

Chromium reuse reduces the levels of chromium in the sludge. Disposal of sludge containing these lower residual quantities of chromium in a sanitary landfill will minimize any environmental problems (USEPA 1979).

Prior to dewatering in mechanical equipment, sludge is normally conditioned by use of ferric salts, lime, polymers, or a combination of these. The quantity and type of chemicals required are dependent upon characteristics of the sludge being handled.

Dewatering with mechanical equipment such as centrifuges generally can produce a cake containing 15 to 30% dry solids. Plate and frame filter presses have been found to produce cakes of 40 to 50% dry solids. The higher capital cost of filter presses may be quickly offset by lower hauling and disposal costs where landfills are located great distances from the tannery or the POTW (USEPA 1979).

Some sludge is disposed of on the land, taking advantage of its lime content for agricultural purposes. One disadvantage of this type of disposal practice is the potential toxic effects of chromium or other constituents on plants, groundwater, and surface water supplies. Lagoons for dewatering have some limited uses. In humid areas where rainfall approximates or exceeds evaporation, such application is not completely satisfactory. Use of lagoons, drying beds, landfills, and landspreading all require key attention to the environmental impacts. Particularly important is the leaching of potential toxic or organic materials to the groundwater supplies or surface waters. Proper controls must be taken to ensure that these conditions will not develop (USEPA 1979).

Under the Resource Conservation and Recovery Act (RCRA) passed by Congress in 1976, solid wastes are divided into two broad categories for the purpose of regulation, namely hazardous wastes and other solid wastes. Final regulations for implementation of this statute have not been promulgated, but they have been proposed (FR 58946-59028, 18 December 1978). Generally this program will standardize the criteria for construction of landfills for non-hazardous solid wastes and establish a stringent permit program and manifest system that will account for hazardous wastes from generation to final disposal.

Under the proposed regulations, wastes may be judged hazardous by four criteria: ignitability, corrosiveness, reactivity, and toxicity (40 CFR 250.13, proposed). Because the leather tanning and finishing industry generates large quantities of corrosive, toxic, and reactive wastes, four waste streams have been defined as hazardous (40 CFR 250.14, proposed):

- wastewater treatment sludge from chrome tannery and beamhouse/tanhouse operations;
- wastewater treatment screenings from sheepskin tannery, split tannery, and retan/finish operations;
- trimmings and shavings from leather tanning and finishing, chrome tannery, split tannery, beamhouse/tanhouse, and retan/finish operations; and
- wastewater treatment sludge from unhairing operations.

In their present form the proposed regulations will require that every load of hazardous waste be tracked at the tannery through the hands of each transporter and then to final disposal at an approved disposal site. The proposed regulations also require chemical analysis of the wastes, use of appropriate containers, submission of reports, and monitoring and inspection of disposal sites. The design as well as the operation of hazardous wastes disposal sites will be regulated also.

In general, recovery or disposal of non-hazardous tannery wastes in an approved sanitary landfill will be required under a state regulatory program, with new open dumps prohibited. Existing state solid and hazardous waste disposal regulations will be superseded unless they meet or exceed the Federal standards.

2.0 IMPACT IDENTIFICATION

The following discussions will identify the major pollutant sources for the leather tanning industry. The pollutant impact will be discussed for each of the impact media.

2.1 AIR

Emissions have not been found to be a major environmental impact of the leather tanning industry, and there are limited data to quantify the generation of these pollutants. Estimates of the quantity of buffing dust and finishing solvents generated by some subcategories are available in the hazardous waste assessment for the industry (SCS Engineers 1976). These are summarized in Table 5. The established and potential sources for emissions that should be addressed by a new source tannery would be expected to include:

- Beamhouse operation - sulfides from the unhairing process.
- Tanning operation - solvents from the degreasing recovery system.
- Finishing operation - dust from the buffing operation and solvents from spray finishes.
- Auxiliary support equipment - emissions from boilers and pollution control equipment.

Odor potential also should be identified in terms of possible sources (e.g., sulfides from unhairing) and their impacts on surrounding areas. Due to the large quantities of putrescible material handled by a tannery, odor problems also may develop if scraps, screenings, sludge, and similar materials are not quickly removed and disposed.

2.2 WATER

The following wastewater parameters are of major pollutional significance for the leather tanning and finishing industry (USEPA 1979):

Table 5. Emissions from the finishing operation of various subcategories of the leather tanning and finishing industry.

Subcategory	Buffing Dust(1)	Finishing Solvents
1. Hair pulp/chrome tan/retan-wet finish	25	450
3. Hair save/non-chrome tan/retan-wet finish	90	-
4. Retan-wet finish	25	450
6. Unhair/chrome tan (through-the-blue)	-	-
* Sheepskin Tannery	50	-
* Split Tannery	180	-
* Leather Finisher	10	450

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* Subcategory used for hazardous waste assessment but not designated for effluent guidelines.

(1) All estimates appear as dry lbs/1000 equivalent hides where equivalent hide weighs approximately 50 lbs.

SOURCE: SCS Engineers. 1976. Assessment of industrial hazardous waste practices, leather tanning and finishing industry.

Biochemical Oxygen Demand
Chemical Oxygen Demand
Total Chromium
Oil and Grease
Sulfide
Total Suspended Solids (TSS)
Nitrogen Content (Ammonia Nitrogen and
  Total Kjeldahl Nitrogen)
Phenols
pH and Alkalinity

Wastewater parameters of minor significance are:

Total Dissolved Solids
Chlorides
Total Volatile Solids
Nitrates and Nitrites
Fecal Coliforms

Priority pollutants of significance are:

- Organics
  - Volatile
  - Semi-Volatile
    - Basic/Neutral Fraction
    - Acidic Fraction

- Inorganics
  - Cyanide
  - Metals

- Pesticides

2.2.1 Wastewater Generation and Characteristics

Wastewater streams generated by the leather tanning and finishing industry are highly variable and process dependent. In view of the numerous modifications that now exist to the basic processes described in Section 1.2, the specific nature of the wastewater for the New Source tannery must be carefully documented and specifically related to the processes anticipated under actual operating conditions.

Process waste stream characterization for the industry should address the following waste materials and pollutant indicators.

- Beamhouse Operation

  Hair
  Manure
  Protein
  Salt
  Flesh
  Hide trimmings

  High pH
  Sulfides
  Grease
  Nitrogen

- Tanhouse Operation

  Dyes (complex organics)
  Degraded proteins
  Salt
  Dissolved organics

  Low pH
  High chrome
  Ammonia
  Color

Retan, color, and fatliquoring operation wastewater would be similar in nature to tanhouse operation wastewaters, and should be reflected in wastewater estimates by a New Source tannery applicant. Finishing operations are usually dry, but liquid wastes could be generated by dust control equipment (e.g., wet scrubbers).

The industry's wastewaters are characterized by the following major pollutants:

- Biochemical oxygen demand (BOD). In most leather tannery wastewaters, the BOD derives principally from organic material, such as dissolved or "pulped" hair and other extraneous hide substances, and from ammonia which is derived from residual bating chemicals and from hydrolytic deamination of proteinaceous hair and hide substance.

The BOD a waste exerts will reduce the dissolved oxygen resources of a body of water. It is possible to reach conditions which totally exhaust the dissolved oxygen in the water resulting in anaerobic conditions and the production of undesirable gases such as hydrogen sulfide and methane. The reduction of dissolved oxygen can be detrimental to fish populations, fish growth rate, and organisms used as fish food. A total lack of oxygen can result in the death of all aerobic aquatic inhabitants in the affected area. Water with a high BOD indicates the presence of decomposing organic matter and associated increased bacterial concentrations that degrade its quality and potential uses. High BOD increases algal concentrations and blooms; these result from decaying organic matter and form the basis of algal populations.

- Chemical oxygen demand. Tannery wastewaters contribute to high COD concentrations due to extraneous hide substance, manure, complex organic and inorganic process chemicals, dyes, and vegetable tannins.

  The COD test measures pollutants more resistant to biological oxidation than the BOD test includes. These pollutants are of increasing interest and concern because of the continuing oxygen demand they exert and their potential health effects. Some pollutants measured by the COD test have been found to have carcinogenic, mutagenic, and similar adverse effects, either singly or in combination. The long life of these pollutants in the environment, the difficulty in removing them by commonly used systems of water purification, and the potential for chlorination converting them into even more hazardous materials magnifies their significance.

- Total suspended solids (TSS). The washing, unhairing, shearing, and finishing operations are the primary sources.

  Suspended solids include both organic and inorganic materials. The inorganic compounds include sand, silt, and clay. The organic fraction includes such materials as grease, oil, and animal and vegetable waste products. These solids may settle out rapidly and bottom deposits are often a mixture of both organic and inorganic solids. Solids may be suspended in water for a time and then settle to the bed of the stream or lake. They may be inert, slowly biodegradable materials, or rapidly decomposable substances. While in suspension they increase the turbidity of the water, reduce light penetration, and impair the photosynthetic activity of aquatic plants.

  Aside from any toxic effect attributable to substances leached out by water, suspended solids may kill fish and shellfish by causing abrasive injuries, by clogging gills and respiratory passages, screening out light, and by promoting and maintaining the development of noxious conditions through oxygen depletion. Suspended solids also reduce the recreational value of the water.

  Some of the solids generated within a tannery, such as hair or scraps, are removed readily by fine screening; other solids settle readily in clarifiers. When not removed, these solids can foul or plug pipes, pumps, and other mechanical equipment.

- Oil and Grease (O & G). This is generated most significantly when pigskins and sheepskins are processed. Other significant sources are from the soaking, fleshing, and fatliquoring processes.

  Even in small quantities, oil and grease cause troublesome taste and odor problems. They produce scum lines on water treatment basin walls and other containers and adversely affect fish and waterfowl. Oil emulsions may adhere to the gills of fish, causing suffocation, and may taint the flesh of fish microorganisms that were exposed to waste oil. Oil deposits in the bottom sediments of water can serve to inhibit normal benthic growth. Oil and grease also exert an oxygen demand in the natural environment.

  Oil and grease levels which are toxic to aquatic organisms vary greatly, depending on the type of pollutant and the species susceptibility. In addition, the presence of oil in water can increase the toxicity of other substances discharged into the receiving bodies of water.

- Chrome. Chrome is generated from the chrome tanning process and subsequent wet processing steps. Trivalent chrome is the only form normally present, since hexavalent chrome use in tanneries is practically non-existent.

  Chromium can produce lung tumors when inhaled and induces skin sensitizations. Large doses of chromates have corrosive effects on the intestinal tract and can cause inflammation of the kidneys. A minimum level for the chromate ion that has no effect on man has not been determined. The toxicity of chromium salts to fish and other aquatic life varies widely with the species, temperature, pH, valence of the chromium, and synergistic or antagonistic effects, especially those of hard water. Fish appear to be relatively tolerant of chromium, but some aquatic invertebrates are quite sensitive.

- Sulfide. This is introduced in the form of sharpeners in the unhairing process.

  A significant portion of alkaline sulfides contained in tannery wastewater converts to hydrogen sulfide at a pH below 8.0, resulting in the release of this gas to the atmosphere. This gas is odorous, and can damage property through paint discoloration. In sewers, hydrogen sulfide can oxidize to sulfuric acid, causing "crown" corrosion and corrosion of equipment in POTW. At higher concentrations this gas can be lethal to operation and maintenance personnel in sewers, and at POTW headworks, primary treatment, and sludge dewatering facilities. This is particularly significant as a hazard in sewer maintenance. Careless mixing of acid and sulfide containing alkaline streams can also be catastrophic within both tanneries and sewers. Sulfide compounds are used extensively in the beamhouse for the unhairing process, and thus are found in tannery effluent.

- Nitrogen (total Kjeldahl nitrogen (TKN) and ammonia). Both nitrogen forms are generated in conjunction with the unhairing and bating processes.

Total Kjeldahl nitrogen is ammonia nitrogen plus organic nitrogen in wastewater. Organic nitrogen is derived primarily from dissolved or pulped proteinaceous hair removed from hides. Hydrolysis of this organic nitrogen during biological treatment yields another significant source of ammonia. Hence, TKN measures the major nitrogen impact upon a waste treatment plant or stream and is an important measure of the potential environmental impact of tannery wastewater.

Evidence exists that ammonia exerts a toxic effect on all aquatic life depending upon the pH, dissolved oxygen level, and the total ammonia concentration in the water. A significant oxygen demand can result from the microbial oxidation of ammonia.

- Phenol. Phenol and substituted phenolics are generated mainly in conjunction with coloring of tanned hides. These sources may include biocides (e.g., pentachlorophenol; 2,4,5 trichlorophenol), synthetic and natural vegetable tannins, carriers for dyes, and a number of other adverse sources all of which contribute to significant levels of phenol in raw wastewaters.

  Chlorination of such waters can produce odoriferous and objectionable tasting chlorophenols which may include o-chlorophenol, p-chlorophenol, 2,6-dichlorophenol, and 2,4-dichlorophenol. Phenolic compounds may adversely affect fish by a direct toxic action or by imparting a taste to the fish flesh. The toxicity of phenol towards fish increases as the dissolved oxygen level is diminished, as the temperature is raised, and as the hardness is lessened. Phenol appears to act as a nerve poison, causing too much blood to get to the gills and to the heart cavity; it appears to have a toxic threshold of 0.1-15 mg/l.

  The human ingestion of a concentrated phenol solution results in severe pain, renal irritation, shock, and possibly death. A total dose of 1.5 grams may be fatal. Phenols can be metabolized and oxidized in waste treatment facilities containing organisms acclimated to the phenol concentration in the wastes.

- pH and Alkalinity. Due to the use of strong bases and acids in the unhairing and tanning processes respectively, wide pH variations and high alkalinities (from the beamhouse) can be expected in tannery waste.

  Leather tanning and finishing plants which include beamhouse (unhairing) operations will invariably have excess alkalinity due to the presence of large quantities of lime. This alkalinity provides buffering capacity to prevent unacceptably low pH, and enhances precipitation of many heavy metals, such as trivalent chromium, found in tannery and other industrial wastewaters.

  Knowledge of the pH of water or wastewater aids in determining measures necessary for corrosion control, pollution control, and disinfection. To protect POTW from corrosion, pH levels of wastewaters entering the

> sewerage system must remain above 5. Waters with a pH below 6.0 corrode waterworks structures, distribution lines, and household plumbing fixtures. This corrosion can add such constituents to drinking water as iron, copper, zinc, cadmium, and lead. Low pH waters not only tend to dissolve metals from structures and fixtures but also tend to redissolve or leach metals from sludges and bottom sediments. The hydrogen ion concentration also can affect the taste of water; at a low pH, water tastes "sour."
>
> Extremes of pH or rapid pH changes can stress or kill aquatic life. Even moderate changes from "acceptable" pH limits can harm some species. Changes in water pH increase the relative toxicity to aquatic life of materials. Metalocyanide complexes can increase a thousand-fold in toxicity with a drop of 1.5 pH units. The toxicity of ammonia similarly is a function of pH. The bactericidal effect of chlorine in most cases lessens as the pH increases, and it is economically advantageous to keep the pH close to 7.

A comprehensive survey of wastewater generation for the entire industry has been conducted in conjunction with the establishment of effluent limitations for the NPDES permit program (USEPA 1979). A summary of raw water data for each subcategory of the industry is included in Table 6. Additional data are available in the Development Document for the industry (USEPA 1979).

2.2.2 Priority Pollutant Generation in Wastewater Streams

Effective control of those pollutants that represent the greatest danger to aquatic ecosystems and to man is basic to environmental protection. The most significant pollutants and pollutant parameters detected in the wastewaters in terms of occurrence and concentration for the industry in general include: the conventional and proposed conventional pollutants BOD_5, TSS, pH, COD, and oil and grease; and the nonconventional pollutants, ammonia, total Kjeldahl nitrogen (TKN), and sulfide. The following priority pollutants have been found at more than two plants and above the nominal limits of detection (USEPA 1979):

2,4,5-trichlorophenol
chloroform
1,2-dichlorobenzene
1,4-dichlorobenzene
ethylbenzene

Table 6. Raw waste loads by subcategory.*

Subcategory Pollutants	1	2	3	4	5	6	7
Flow - (gal/1b)	4.6	5.5	4.0	1.7	3.3	2.5	18.9
BOD_5	1620/62.3	983/45.1	1180/39.2	776/11.0	1000/27.6	2460/51.3	349/40.5
TSS	2410/92.3	1930/88.3	1680/56.1	818/11.6	632/17.4	3870/80.7	388/45
COD	4640/178	2610/120	5120/171	3120/44.2	1700/46.8	6400/133	914/106
Oil and Grease	401/15.4	244/11.2	339/11.3	272/3.85	343/9.45	556/11.6	144/16.7
Total Cr	76/2.9	31/1.4	11/0.38	53/0.75	68/1.86	104/2.16	12.9/1.5
Sulfide	64/2.47	20/0.92	68/2.26	1.1/0.015	3.2/0.089	118/2.46	0.2/0.08
TKN	328/12.6	137/6.3	202/6.75	212/3.0	168/4.63	460/9.6	53/6.2
Ammonia	104/3.98	90/4.15	90/3.0	109/1.55	36/1.00	120/2.5	13/1.54
Phenol	1.0/0.038	2.2/0.1	1.2/0.04	3.9/0.055	1.2/0.034	1.5/0.03	0.3/0.03

*Geometric mean of collected data, reported as: (mg/1) / (1b./1000 1b.) raw material

Subcategory 1 - Hair Pulp/Chrome Tan/Retan-Wet Finish
Subcategory 2 - Hair Save/Chrome Tan/Retan-Wet Finish
Subcategory 3 - Hair Save/Nonchrome Tan/Retan-Wet Finish
Subcategory 4 - Retan-Wet Finish
Subcategory 5 - No Beamhouse
Subcategory 6 - Through-the-Blue
Subcategory 7 - Shearlings

SOURCE: U.S. Environmental Protection Agency. 1979. Preliminary draft development document for proposed effluent limitations guidelines and new source performance standards for the leather tanning and finishing point source category.

methylene chloride (dichloromethane)
naphthalene
pentachlorophenol
phenol
bis (2-ethylhexyl) phthalate
toluene
chromium
copper
cyanide
lead
nickel
zinc

Of the 129 priority pollutants identified by USEPA, 46 have been identified in the raw wastewaters of the leather tanning and finishing industry. The number of priority pollutants is higher when beamhouse operations using the hair pulp process are present.

Several toxic pollutants are major ingredients of chemicals used in tannery processes; several others are used as solvents and dye carriers. Many occur as minor or trace components in other chemicals. The most heavily used toxic pollutant in leather tanning is chromium, but there are several others used in significant amounts. These include:

- syntans based on naphthalene and phenol;
- 4-nitrophenol (a biocide, as well as a waterproofing agent);
- pentachlorophenol (a preservative and biocide);
- hexachloroethane, ethylbenzene and toluene solvents;
- 2,4,6-trichlorophenol (a biocide); and
- biocides based on cresol.

The inorganic toxic pollutants (including zinc, lead, nickel, and copper) typically originate in organometallic dyes. Cyanide also is found in dyes, and probably in natural tannins as well. The specific ingredients of the chemical formulations used in the tanning industry often are not known by the tanner, particularly for compounds used in small quantities. The supplier also may not have the exact formulation of these products or may be unwilling to release this information. Many of the tanning chemical solutions are special formulations, prepared to serve a specific function rather than developed with consideration for the specific chemical activity of each ingredient.

2.3 SOLID WASTE

Solid wastes from the leather tanning industry may include both solid materials (e.g., leather trimmings) and semi-liquid wastes that are most commonly disposed on land (e.g., wastewater treatment sludges). Reported significant sources of solid waste include (SCS Engineers 1976):

- Leather wastes. Pieces of leather in various stages of processing are routinely generated as the hide is trimmed for various tannery operations. Fine leather fibers also are generated in conjunction with buffing and shaving. Leather wastes comprise about 35% of the industry solid wastes.
- Finishing wastes. Residues from recycled solutions, usually in a slurry form, typically constitute about 2% of the industry solid wastes.
- Wastewater treatment solids. Essentially all tanneries screen their wastewater and generate solid waste. Many pretreatment facilities for tanneries generate sludge solids, as do all direct discharge systems. Waste treatment sludges constitute 60% of the process solid waste in the industry.
- Floor sweepings. Included in this category are shipping materials (e.g., twine) and excess salt solids from cured hides. This source represents about 3% of the process solid wastes from the industry.

Additional solid waste generation estimates for the industry have been summarized in Table 7. These estimates include total process solid waste and total hazardous (or potentially hazardous) solid wastes. Information in the table is also provided for tanneries not included in the effluent guidelines subcategorization in Section 1.1. Additional breakdowns of these data by specific process are available in the literature (SCS Engineers 1976) and could provide guidance for the applicant to use in estimating quantities of solid wastes to be generated by a new tannery (USEPA 1979).

Table 7. Solid waste generation estimates for the leather tanning industry by effluent guidelines subcategory.

		1977 Solid Waste Estimate(1)				1983 Solid Waste Estimate(1)			
		Total		Hazardous(2)		Total		Hazardous(2)	
	Subcategory	(Dry)	(Wet)	(Dry)	(Wet)	(Dry)	(Wet)	(Dry)	(Wet)
1.	Hair pulp/chrome tan/retan-wet finish	1,800	5,400	1,300	4,900	1,800	5,400	1,300	4,900
3.	Hair save/non-chrome tan/retan-wet finish	2,700	12,000	None	None	2,800	13,000	None	None
4.	Retan-wet finish	1,200	2,100	920	1,800	1,200	2,300	950	2,100
6.	Unhair/chrome tan (through-the-blue)	2,600	10,200	2,400	10,000	2,600	10,200	2,400	10,000
*	Sheepskin tannery	890	2,100	540	1,700	910	2,300	560	1,800
*	Split tannery	4,300	8,900	4,000	8,600	4,300	8,900	4,100	8,700
*	Leather finishers	130	240	55	160	130	260	58	170

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* Subcategory not designated for effluent guidelines.

(1) All estimate as kg/1000 equivalent hide, where an equivalent hide weighs about 50 pounds.

(2) Defined as hazardous or potentially hazardous.

SOURCE: SCS Engineers. 1976. Assessment of industrial hazardous waste practices leather tanning and finishing industry.

Hazardous compounds identified in sludges from tannery wastewater treatment facilities are shown in Table 8 to include (SCS Engineers 1976):

- Chromium. The chemistry of chromium is very complex, especially in untreated raw wastewaters where interferences from complexing mechanisms such as chelation by organic matter and dissolution due to presence of carbonates can cause deviation from predicted behavior in treatment systems. Disposal of sludges containing very high trivalent chromium concentrations can potentially cause problems in uncontrollable landfills. Incineration, or similar destructive oxidation processes can produce hexavalent chromium, which in turn is potentially more toxic than trivalent chromium under certain circumstances. Studies on the effects of disposal of sludges containing trivalent chromium on agricultural land have produced conflicting conclusions. Some studies have not shown adverse effects, and in fact the nitrogen content of sludges have shown some beneficial effects. In other cases where high rates of chrome sludge application are used, distinct growth inhibition and plant tissue uptake have been noted. Therefore, the use of agricultural land for tannery or POTW sludge disposal should not be generally adopted in light of potential for long-term accumulation and toxicity in soils and plant tissue (USEPA 1979).

- Copper. This may leach from a landfill into groundwater.

- Lead. This may leach from a landfill into groundwater.

- Sulfides. These may leach from a landfill into groundwater. They may be converted to hydrogen sulfide in a landfill, as the pH is reduced by biological activity or mixing with other waste streams.

- Phenols. These may be leached from a landfill into groundwater. These compounds may be extremely persistent in the environment and may be significant in trace amounts.

Disposal of hazardous solid tannery waste has the potential for creating environmental problems if it is not properly handled. The use of sludge lagoons, landspreading, and landfilling techniques require attention to proper controls to assure that the leaching of toxic substances to groundwater or surface waters does not occur. Spreading tannery sludge on the land may also be a potential problem depending upon the bacteria present, salt content, presence of metals, and ultimate use of the crop being grown on the land receiving the sludge. Guidance on issues to consider in landspreading of sludge may be found in references such as Application of Sludges and Wastewaters to Agricultural Land: A Planning and Educational Guide, USEPA, March 1978.

Table 8. "Typical" tannery wastewater treatment plant sludge characteristics.*

Constituent	Chrome leather tannery pretreatment/treatment sludge before dewatering	Chrome leather tannery pretreatment/treatment sludge after dewatering	Chrome leather tannery sewer sump sludge (not dewatered)	Vegetable leather tannery secondary treatment sludge (not dewatered)
Solids content (%)	5-10	20-30	5-15	3-6
Chromium (mg/l)	3,000-6,000	10,000-15,000	2,000-4,000	<5
Copper (mg/l)	100-150	150-200	100-200	<10
Lead (mg/l)	10-25	50-150	10-25	<5
Sulfides (mg/l)	20-50	50-150	30-60	25-50
Phenols (mg/l)	<10	<10	<10	<1

* All values are based on wet weight.

SOURCE: SCS Engineers. 1976. Assessment of industrial hazardous waste practices, leather tanning and finishing industry.

If the RCRA regulations are promulgated as presently proposed, most of the industry's solid waste will have to be disposed of in USEPA approved landfills in accordance with Subtitle C regulations. These sites will have to be designed and operated to satisfy all significant environmental concerns regarding disposal of tannery waste. However, consideration should be given to the other wastes to be disposed of to assure that waste interaction does not create or cause leaching of any hazardous substance from the site. (See Section 3.3 for a discussion of sludge disposal alternative technologies).

2.4 OTHER IMPACTS

The leather tanning industry can have significant impacts on public health and the ecology of our environment if pollutants from the industry processes are uncontrolled. The industry can have other impacts that are not directly generated by the tanning process. In addition, the wastes from the industry can affect other pollution control systems. These potentials must be addressed by the applicant.

2.4.1 Aesthetics

New source leather tanneries are usually small, enclosed complexes that should be designed to blend with the natural surroundings. Although tanneries do not normally require large tracts of land, waste treatment and disposal needs for the tannery (e.g., a wastewater treatment plant or a solid waste landfill) may require sizable tracts of land and may detract considerably from the surrounding landscape. Also, due to the putrescible matter from the fleshing and trimming processes, the existence of the wastewater treatment plant, and the sulfur used in the unhairing process, odor from a leather tannery may become highly objectionable. Particularly in rural and suburban areas, leather tanneries along with their waste treatment facilities can represent a significant intrusion into the environmental landscape. Measures to minimize the impact on the environment must be developed during site selection and tannery planning design. The applicant should consider the following factors to reduce potential aesthetic impacts:

- Existing Nature of the Area. The topography and major land uses in the area of the candidate sites are important. Topographic conditions and existing trees and vegetation visual barriers can be used to screen the operation from view. A lack of topographic relief and vegetation would require other means of minimizing impact, such as regrading or the planting of vegetation buffers.

- Proximity of Parks and Other Areas Where People Congregate for Recreation and Other Activities. The location of public use areas should be mapped and presented in the EID. Representative views of the plant site from observation points should be described. The visual effects on these recreational areas should be described in the EID in order to develop the appropriate mitigative measures.

- Transportation System. The visual impact of new access roads, rail lines, haul roads, barge docking, pipelines, and storage facilities on the landscape or waterfront should be considered. Locations, construction methods and materials, and maintenance should be specified.

2.4.2 Noise

The major sources of noise associated with the leather tanning industry include:

- fans and blowers;
- pumps and motors;
- mechanical unhairing equipment;
- splitting and trimming equipment;
- mechanical fleshing equipment;
- transfer trucks and equipment;
- compressors and sprayers;
- scrubbers and buffers; and
- wastewater treatment equipment (e.g., air compressors).

Various source and operational control methods are available which can effectively mitigate the undesirable noise impacts. Such measures include:

- enclosed process machines;
- mufflers on engines;
- sound barriers and isolation;
- vibration insulation; and
- acoustically lined plenums.

The USEPA has recommended a maximum 75 dBA, 8-hour exposure level to protect workers from loss of hearing. A maximum 55 dBA background exposure level is also recommended to protect from annoyance during outdoor activity (USEPA 1974d). A suitable methodology to evaluate noise generated from a proposed new source tannery would require the applicant to:

- Identify all noise-sensitive land uses and activities adjoining the proposed plant site (e.g., schools, parks, hospitals, and businesses in the urban environment; homes and wildlife sanctuaries in the rural environment).
- Measure the existing ambient noise levels of the areas adjoining the site.
- Identify existing noise sources, such as traffic, aircraft flyover, and other industry, in the general area.
- Determine whether there are any state or local noise regulations that apply to the site.
- Calculate the noise level of the tannery processes, compare that value with the existing area noise levels and the applicable noise regulations.
- Assess the impact of the operation's noise and, if required, determine noise abatement measures to minimize the impact (e.g., quieter equipment, noise barriers, improved maintenance schedules).

2.4.3 Energy Supply

The impact of a leather tanning facility on local energy supplies will depend largely on the type of processes proposed and the ancillary facilities. The applicant should evaluate the energy efficiencies of all processes considered during project planning and then consider the alternatives. Feasible design modifications also should be considered in order to reduce energy consumption.

The design of end-of-pipe wastewater treatment plant units is dependent on the performance of in-plant and pretreatment technologies for specific waste streams originating within a tannery. Reuse of process streams, recovery and reuse of chemicals, and reduction of wastewater volume are primary aspects of these technologies. Each of these reuse and reduction processes is inherently energy conserving in the production of leather and in wastewater treatment.

The removal or reduction of pollutants in any wastewater stream requires an energy expenditure. The higher levels of treatment produce a higher quality effluent with lower levels of pollutants. This means a greater energy consumption than at lesser levels of performance.

At a minimum, the applicant should provide the following information:

- Total external energy demand for operation of tannery.
- Total energy available on site.
- Energy demands by type.
- Proposed measures to reduce energy demand and increase plant efficiency.
- Proposed energy sources and alternatives.

The New Source Tannery EID also should specifically address the topics in the next sections.

2.4.3.1 Energy Consumption and Conservation

Leather tanning facilities are not large users of energy. The various leather tanning processes use a small amount of energy, while the facilities' wastewater treatment plants use the majority of the energy. The focus of wastewater treatment and control for BAT level of performance is on in-plant and pretreatment technologies for specific waste streams originating within a tannery. Reuse of process streams, recovery and reuse of chemicals, and reduction of wastewater volume are primary aspects of these technologies. Each of these is inherently energy conserving in the production of leather and in wastewater treatment.

The removal or reduction of pollutants in any wastewater stream requires an energy expenditure. The control technologies available to meet NSPS produce a higher quality effluent with lower levels of pollutants. This means a greater energy consumption than at lesser levels of performance. The increased energy requirements to meet the NSPS control requirements are projected to be small in absolute and relative terms (USEPA 1979).

2.4.3.2 Cogeneration

The potential for cogeneration (e.g., using steam to generate electricity on-site and for process requirements) should be evaluated in the EID. However, it is probable that the economic incentive for this technique will not exist for most tanneries because of the relatively limited energy consumption for the industry. The applicant should investigate satisfying all or a portion of the tannery energy needs using waste energy from nearby industrial facilities.

2.4.4 Socioeconomics

Leather tanning facilities are usually small complexes but are often associated with large cattle feedlots or meat packing plants. The introduction of a leather tanning facility into a community may cause land use, economic, and social changes. Therefore, it is necessary for an applicant to understand the types of impacts or changes that may occur so that they can be evaluated adequately. The importance of these changes usually depends on the size of the existing community where the facility is located. The trend now is for leather tanning facilities to be located in more rural areas instead of traditional urban areas. The significance of the changes caused by a facility of a given size normally will be greater near a small rural community than near a large urban area. This is due to the fact that a small rural community is more likely to have a nonmanufacturing economic base and a lower per capita income, fewer social groups, a more limited socioeconomic infrastructure, and fewer leisure pursuits than a large urban area. There are situations, however, in which the changes in a small community may not be significant and, conversely, in which they may be considerable in an urban area. For example, a small community may have had a manufacturing (or natural resource) economic base that has declined. As a result, such a community may have a high incidence of unemployment in a skilled labor force and a surplus of housing. Conversely, a rapidly growing urban area may be severely strained to provide the labor force and services required for a new leather tanning facility.

The rate at which changes occur (regardless of the circumstances) also is often an important determinant of the significance of the changes. The applicant should distinguish clearly between those changes occasioned by the construction of the facility, and those resulting from its operation. The former changes could be substantial but usually are temporary; the latter may or may not be substantial, but normally are more permanent in nature. The potential impacts which should be evaluated include:

- Increased land consumption and rate of land development.
- Land use pattern and compatibility changes.
- Economic base multiplier effects.
- Population size and composition changes.
- Increased labor force participation and lower unemployment rates.
- Increased vehicular traffic and congestion.
- Loss of prime agricultural land and environmentally sensitive areas.
- Increased demand for community facilities and services.
- Increased demand for water supply, sewage treatment, and solid waste disposal facilities.

During the construction phase, the impact will be greater if the project requires large numbers of construction workers to be brought in from outside the community than if local unemployed workers are available. The potential impacts include:

- Creation of social tension.
- Short-term expansion of the local economy.
- Demand for increased police and fire protection, public utilities, medical facilities, recreation facilities, and other public services.
- Increased demand for housing on a short-term basis.
- Strained economic budget in the community where existing infrastructure becomes inadequate.
- Increased congestion from construction traffic.

Various methods of reducing the strain on the budget of the local community during the construction phase should be explored. For example, the company itself may build the housing and recreation facilities and provide the utility services and medical facilities for its imported construction force; or the tannery may prepay taxes, and the community may agree to a corresponding reduction in the property taxes paid later. Alternatively, the community may float a bond issue, taking advantage of its tax-exempt status, and the company may agree to reimburse the community as payments of principal and interest become due.

During operation, the more extreme adverse changes of the construction phase are likely to disappear. Long-term changes may be profound, but less extreme, because they evolve over a longer period of time and may be both beneficial and adverse.

The permit applicant should document fully in the EID the range of potential impacts that are expected and demonstrate how possible adverse changes will be handled. For example, an increased tax base generally is regarded as a positive impact. The revenue from it usually is adequate to support the additional infrastructure required as the operating employees and their families move into the community. The spending and respending of the earnings of these employees has a multiplier effect on the local economy, as do the interindustry linkages created by the leather tanning facilities. The linkages may be backward (those of the facility's suppliers) or forward (those of the facility's markets).

Socially, the community may benefit as the increased tax base permits the provision of more diverse services of a higher quality, and the variety of its interests increases with growth in population. Conversely, the transformation of a small community into a larger community may be regarded as an adverse change by some of the residents who chose to live in the community, as well as by those who grew up there and stayed, because of its small town amenities.

The applicant also should consider the economic repercussions if, for example, the quality of the air and water declines as a result of wastes generated by the leather tanning facility. In some cases, traditional sectors of economic activity may decline because labor is drawn away from them into higher paying industrial jobs. Also the tourist sector may decline if air and water pollution is noticeable or if the landscape is degraded.

Thus, the applicant's framework for analyzing the socioeconomic impacts of the location of a leather tanning facility must be comprehensive. Most of the changes described can and should be measured to assess fully the potential costs and benefits. The applicant should distinguish clearly between the short-term (construction) and long-term (operation) changes, although some changes may be common to both (e.g., the provision of infrastructure). The significance of the changes depends not only on their absolute magnitude, but on the rate at which they occur. The applicant should also develop and maintain close coordination with state, regional, and local planning and zoning authorities to ensure full understanding of all existing and/or proposed land use plans and other related regulations.

USEPA's Office of Environmental Review is developing a methodology to be used to forecast the socioeconomic impacts of new source industries and the environmental residuals associated with those impacts. The manual describing the method and its use is expected to be available in mid-1980.

2.4.5 Raw Materials Shipment and Handling

The leather tanning industry uses raw materials that may have adverse environmental effects due to improper handling or accidents. The following materials should be evaluated:

- hides and skins, describing their nature upon receipt (e.g., raw, brine cured, through-the-blue tanned);
- tanning agents (e.g., chrome, vegetable, alum, syntans);
- finishing materials;
- solvents;
- bleaching agents;
- dyes;
- pickling liquors; and
- other process chemicals.

The significant factors for these materials include storage, handling, and contingency methods to avoid adverse impacts in the event of an accident.

The hide raw materials sources especially should be characterized by the applicant:

- Sheepskins are mainly imported, so the proximity of the tannery to port facilities should be indicated.
- Reliance on through-the-blue tanned leather as a raw material should be supported by the probable source (e.g., existing versus new tanneries).
- General availability of the tannery agent (e.g., chrome, alum, or vegetable extract) might have a significant effect on product mix.
- Location and operation of brine curing facilities for the hide source should be addressed because of the putrescible nature of uncured hides and the associates difficulties with transport (e.g., odor at the new tannery, spoiled hides requiring disposal).

2.4.6 Site Preparation and Construction

The environmental effects of site preparation and construction of new leather tanneries are common to land disturbing activities on construction sites in general. Erosion, dust, noise, vehicular traffic and emissions, and some loss of wildlife habitats are to be expected and minimized through good construction practices wherever possible. At present, however, neither the quantities of the various pollutants resulting from site preparation and construction nor their effects on the integrity of aquatic and terrestrial ecosystems have been studied sufficiently to permit broad generalizations.

The major pollutant at a construction site is loosened soil that finds its way into the adjacent water bodies and becomes sediment. Common remedial measures include, but are not limited to, proper planning at all stages of development and application of modern control technology to minimize the production of huge loads of sediment. Specific control measures include:

- the use of paved channels or pipelines to prevent surface erosion;
- staging or phasing of clearing, grubbing, and excavation activities to avoid periods of heavy rainfall;
- the use of storage ponds to serve as sediment traps, where the overflow may be carefully controlled; and
- the use of mulch or seeding immediately following disturbance.

If the applicant chooses to establish temporary or permanent ground cover, grasses normally are more valuable than shrubs or trees because of their extensive root systems that entrap soil. Grasses may be seeded by sodding, plugging, or sprigging. During early growth, grasses should be supplemented with mulches of wood chips, straw, and jute mats. Wood fiber mulch has also been used as an antierosion technique. The mulch, prepared commercially from waste wood products, is applied with water in a hydroseeder.

The applicant must consider the capacity of the soils and geology to accommodate production and waste storage. Problems which would require special consideration include:

- unstable soils;
- steep topography;
- presence of wetlands;
- location relative to floodplains;
- permeability of soils; and
- erosion problems during construction and operation.

In addition to the impact assessment framework provided in the USEPA document, Environmental Impact Assessment Guidelines for Selected New Source Industries, the permit applicant should tailor the conservation practices to the site under consideration in order to account for and to protect site specific features, including:

- critical habitats;
- archaeological/historical sites;
- high quality streams; and
- other sensitive areas on the site.

The evaluation of site limitations should not be limited to the immediate vicinity of the project but should consider areawide restrictions, such as:

- proximity to national refuges, parks, and other pristine areas;

- area water resource compatibility with industrial development;
- existing hazardous solid waste disposal facilities for the area;
- potential for developing solid waste disposal systems; and
- community attitudes and goals relative to industrial development.

These should be addressed with respect to the mitigative techniques available to the applicant. (See Section 4.0 for a detailed discussion of site selection criteria).

2.4.7 Effects on Municipal Treatment Systems

The usual alternative to treatment and discharge of treated wastewater effluents is pretreatment for discharge to a municipal wastewater treatment facility. For the new source tannery, the effluent limits for both of these alternatives are identical and equal to BAT limits. When evaluating the pretreatment alternative, the applicant should consider the following problems:

- large pieces of scrap hide and leather clogging or fouling operating equipment;
- excessive quantities of hair and other small-scale, screenable solids;
- highly acidic or alkaline waste streams;
- wastewater flow surges;
- excessive loadings of suspended solids, settleable solids, and BOD_5, consistently or in surges;
- odors, facilities corrosion, very high dissolved oxygen demand in biological treatment system aeration basins, and hazardous gas generation from sulfide bearing wastes;
- a potential future problem with disposal of sludges containing chrome; and
- pass through of ammonia nitrogen.

These factors also are significant for an industry operated waste treatment facility. The pretreatment standards for new sources (PSNS), if adopted as proposed, will require pretreatment controls that are adequate to alleviate these problems.

2.5 MODELING OF IMPACTS

The ability to forecast environmental impacts accurately often is improved by the use of mathematical modeling of the dispersion and dissipation of air and water pollutants as well as the effects of storm runoff. Two of the most widely used and accepted models are:

- DOSAG (and its modifications); and
- the QUAL series of models developed by the Texas Water Development Board and modified by Water Resources Engineers, Inc.

These are steady-state, one-dimensional models useful in evaluating stream impacts. Some of the parameters that these models simulate are:

- Dissolved oxygen.
- BOD.
- Temperature.
- pH.
- Solids.

The data required for these models include (1976i):

DOSAG-I

- Flow rates for system inputs and withdrawals.
- Information on reaches, junctions, stretches, headwater reaches.
- Reaction coefficients.
- Concentrations of inflows.
- Stream temperature.

QUAL-II

- Identification and description of stream reaches.
- Initial conditions.
- Hydraulic coefficients for determining velocity and depth.

- Reaction coefficients.
- Headwater data.
- Waste loadings and runoff conditions.
- If temperature is to be modeled, also requires sky cover, wet bulb/dry bulb air temperature, atmospheric pressure, wind speed, evaporation coefficient, and basin elevation.

Other models are available for non-steady state conditions and two dimensions, as required in modeling estuaries, including:

- RECEIV and RECEIV II, developed by Raytheon for the USEPA Water Planning Division.

These models can evaluate both conservative (e.g., dissolved solids, metals) and non-conservative materials subject to first order reaction kinetics (e.g., BOD, DO). The data required as input to both of these models include:

- Tidal variations.
- Water surface elevations, area, and depth.
- Bottom roughness coefficients.
- Meteorological data, including rainfall, evaporation, and wind velocity and direction.
- Downstream boundary conditions.
- Junction and channel data.
- Water temperature.
- Initial pollutant concentrations.
- Inflow data.
- Oxygen saturation and reaeration coefficients.

In addition, there are many available water quality models that were developed in association with NPDES activity and the need for optimization of waste load schemes for an entire river basin.

There are also available mathematical models that have been used for air pollution studies and solid waste management optimization. A complete discussion of available air quality modeling techniques is presented in "Guideline on Air Quality Models," EPA-450/2-78-027 (USEPA 1978e). Examples of the application of these models include:

- For short-term dispersion modeling of point sources, USEPA's PTMAX, PTDIS, and PTMTP models may be employed.
- For modeling of long-term concentrations over larger areas, the USEPA Climatological Dispersion Model may be used for point and area sources.

Input data requirements for air quality modeling include descriptions of the meteorological setting, the existing air quality, the existing air pollutant emissions, and the anticipated emissions from the new source. Pollutant sources may include (USEPA 1978e):

- Point sources. Generally considered a major source (e.g., greater than 50 tons/year) from a stack or group of stacks.
- Line sources. Generally confined to roadways and streets with well-defined motor vehicle movements.
- Area sources. Typically treated as a grid network of square areas with emissions distributed uniformly within each grid square.

In general, the use of mathematical models is indicated when arithmetic calculations are too repetitious or too complex. Their use also simplifies analysis of systems with intricate interaction variables. Models thus offer a convenient way of describing the behavior of environmental systems.

3.0 POLLUTION CONTROL

New sources must attain discharge levels which are indicated as achievable using technological options which meet the New Source Performance Standards (NSPS). They may be the technologies identified by USEPA in the development of these standards or they may be alternatives which meet these standards by other techniques. For waste streams not specifically addressed by NSPS, control applications which represent the state of the art should be described in the EID. The permit applicant must demonstrate that NSPS will be met. The sections which follow identify and describe typical Standards of Performance and state of the art technologies with which NSPS can be met.

3.1 AIR - STANDARDS OF PERFORMANCE TECHNOLOGY

Air emissions from tanning and finishing operations are primarily from the following sources: auxiliary boilers for in-plant heating, dust from the buffing step of the finishing operations, solvents from the degreasing or finishing operations, and possibly hydrogen sulfide from the unhairing process. Odor may also cause air quality problems, due to either uncontrolled sulfides or putrescible solid waste materials. In addition, volatile organic compounds may be released to the atmosphere by aeration systems in biological treatment.

3.1.1 Boiler Equipment

Boiler flue gas may contain several air contaminants controlled by PSD and NAAQS (e.g., total suspended particulates, nitrogen oxides, sulfur dioxide). However, these are low volume sources, so that oil and gas-fired units usually require no pollution control measures to comply with guidelines. If a large coal-fired boiler were proposed for the tannery, then wet scrubbers or electrostatic precipitators to remove fly ash from the stack gas might be required. These units are capable of 98+% removal of fly ash.

3.1.2 Buffing Dust Control

The major potential source of particulate emissions from a tannery is from hide buffing operations. Most tanneries control this by wet scrubbing of the buffing area exhaust. Hide buffing particulates also are of concern due to their chrome content. The wet scrubbing operation transfers this waste material either to the liquid or solid waste streams. Buffing dust from the wet scrubber is usually removed as a sludge for disposal with the other chrome bearing tannery waste.

3.1.3 Hydrogen Sulfide Control

Hydrogen sulfide is the other potential air pollutant of consequence originating from leather tannery wastes. A significant portion of alkaline sulfides contained in tannery wastewater can be converted to hydrogen sulfide at a pH below 9.0, resulting in the release of this gas to the atmosphere. This gas is odorous, and can result in property damage through paint discoloration. In sewers, hydrogen sulfide can be oxidized to sulfuric acid, causing "crown" corrosion and corrosion of equipment. At higher concentrations this gas can be lethal to operation and maintenance personnel in sewers, and at POTW headworks, primary treatment, and sludge dewatering facilities. This is particularly significant as a hazard in sewer maintenance. Further, careless mixing of acid and sulfide containing alkaline streams can also be catastrophic both within tanneries and in sewers.

The sulfide content of tannery wastes must be reduced and maintained at a low level for other treatment systems to work, to protect the health and lives of workers exposed to leather tanning waste waters, and to minimize the potential for air pollution from any waste treatment system. Because of the overriding health and safety considerations associated with hydrogen sulfide control, it should never constitute a significant air pollution problem. However, a description of the facilities proposed for hydrogen sulfide control is necessary to assess adequately the potential health and safety impacts of the tannery.

3.1.4 Ammonia

A potential air pollution source is the ammonia discharged into the air from specific treatment equipment for ammonia removal. Stripping the wastewater by any gaseous media would almost certainly produce an ammonia vapor stream that would be discharged into the atmosphere. Ammonia may be released as a free gas from a wastewater stream containing ammonium hydroxide wherever the pH is in a specific alkaline range. Ammonia would be converted to nitrates and nitrites in the presence of air and the proper bacteria in an extended air or activated sludge type of treatment system. Ammonia originates primarily from the ammonium salts used in the bating step and may be stripped from high pH wastes even without specially designed ammonia stripping facilities. It is necessary that all pollution control systems be addressed from the perspective of pollutant transfer to other media.

3.1.5 Odor

Odor can be associated with sulfide-bearing wastewater streams and with decay of putrescible waste materials such as trimmings and fleshings. The control of these materials should be addressed in the EID. The applicant should specifically identify the control techniques proposed to minimize odor generation from the tannery:

- Closed containers should be available for solid waste materials.
- Daily or more frequent removal of wastes should be indicated.
- Controls and detection instrumentation for hydrogen sulfide in the plant atmosphere should be identified.

3.2 WATER - STANDARDS OF PERFORMANCE TECHNOLOGY

3.2.1 In-Plant Controls

Appraisals of plant waste production must first investigate the manufacturing cycle for any modifications which can reduce the waste flow and the concentration of waste constituents. Particular emphasis rests on reducing those factors which pose problems in treatment of the total waste stream. In some instances, reuse or recovery of materials from process solutions can produce economies which will at least partially offset costs.

Process changes and waste stream segregation are two methods of pollutant reduction and/or control essential to achieving the recommended effluent limitations, wherever appropriate.

A number of tanneries are considering a variety of process change methods which could result in reduced waste loads, increased efficiency in use of chemicals, and reduction of total water use. Tannery justification for these process change methods depends to some extent on the costs of installation and operation and the benefits in whatever form for the particular tannery. An important factor in this decision is the effect of any process change on the quality of the finished leather product (USEPA 1979).

The following steps can often reduce pollutants and the costs of waste treatment (USEPA 1979):

Process Changes

Process changes have been difficult to make in this industry because of the diverse tanning methods employed. While tanning operations traditionally employed the batch system, it is possible that more of the chemical applications as well as the washing and rinsing could be handled more efficiently on a counter-current continuous flow basis. This would achieve maximum utilization of all active ingredients, leaving only concentrated wastes of small volumes for treatment and disposal. Substitution of effluents from one process for make-up water in another generally is feasible at some points within a tannery. Before tanneries can make this change however, they must establish the quantity of water required for each operation.

Substitution of Process Ingredients

Several options exist for the chemicals used in tanning:

- Sulfides used in tanning can be replaced with dimethylamine.
- Synthetic tanning agents (syntans) can reduce contamination normally associated with vegetable tanning.
- Unhairing can use enzymes to facilitate mechanical hair removal, improving the economic attractiveness of unhairing as an alternative to the high pollutant generating hair pulping process.

The merits of these substitution alternatives as well as similar opportunities in other processes should be evaluated by the applicant.

Water Conservation and Reuse

Water recycle and reuse should be maximized in a new tannery as the initial step in the water pollution control effort. Numerous techniques for flow reduction have been demonstrated in tanneries throughout the world, but the application of these techniques to a new tannery is dependent on the process needs of the particular tanner. The application of the following water reuse and recycle techniques should be addressed for each new tannery. Engineering, operation, and process modification aspects of water conservation measures should be considered.

- Rinsing or washing hides in batches rather than using a continuous rinse system should be examined. This holds potential for the most significant water savings of any process modification, since hides are rinsed after every major process step.
- Timers, preset meters, and other instrumentation (e.g., conductivity probes) should be considered for controlling rinse water volumes.
- Spent wash water and rinse water should be considered for process solution makeup.
- Non-contact cooling water (e.g., vacuum driers) should be evaluated for recirculation potential.
- Process equipment alternatives (e.g., hide processors, paddle vats, pumpable drums, float storage tanks) should be considered.
- Operation techniques and procedures should be developed to minimize wastewater (e.g., flow restriction nozzles on washup hoses).

Associated with a water use reduction may be an increase in a pollutant concentration in pretreated discharges to municipal systems. Most municipal ordinances regulating discharges to a sewer specify concentration limits. A joint understanding of the actual municipal requirements at a specific sewer inlet and of the likely consequences of a water reduction program in a tannery would be a vital first step controlling wastewater volume, pollutant concentration, and/or pollutant loading.

Recovery and Reuse of Process Chemicals

The most efficient methods for eliminating pollutants from tannery wastes are the reuse of process solutions and the recovery of materials normally wasted. These both have been demonstrated effective for waste constituent reduction, and the new tannery should consider the possibility of process solution reuse, recycle, or recovery. Alternatives which bear consideration include:

- Reuse or recycle of unhairing solutions. This requires removal of solids from spent solutions, refortification with lime and sharpeners, and addition of make-up water.
- Reuse of chrome tanning solutions. This can be performed either by settling, refortification, and reuse of the solution as the principal tanning agent or by reusing spent liquor for retanning.
- Reuse of vegetable tanning solutions. The Liritan process employs such a technique by counter-current flow of tannage in relation to the hides.
- Reuse of retanning liquors or reuse of spent tanning liquors.
- Reuse of pickle liquors. Spent pickle liquors can be refortified for reuse and also can be used as makeup for pickle liquor.
- Reduce lime used in unhairing liquors. Excess lime is commonly used for unhairing because it is easier to control the process in this manner. Experiments have shown that the lime required for effective unhairing is less than is required to saturate the protein (USEPA 1979).
- Systems for recovery of sulfides from unhairing liquor. A pilot system has recovered sulfide by acidifying the unhairing waste to produce hydrogen sulfide (H_2S) and then scrubbing the H_2S from the air stream with sodium hydroxide (NaOH) to produce sodium sulfide which can be reused (USEPA 1977b).
- Recovery of chrome from spent tanning liquors. This is becoming more attractive as the cost of trivalent chromium salts continues to climb. A chrome recovery system can use lime precipitation of chrome as chromium hydroxide sludge, sludge dewatering, and acidification of the chrome hydroxide cake with sulfuric acid to produce an acidic chromium sulfate solution (USEPA 1977a).
- Recovery of system blowdown solutions. System blowdown is required to prevent buildup of contaminants in tanning, unhairing, washing, and other process streams where extensive recycling is practiced. Vegetable tanners should consider concentrating tan solution blowdown for use as a retanning additive.

Stream Segregation for Separate Pretreatment

Stream segregation is not an in-plant treatment technology, per se. It is, in reality, a critical installation or first step to implement most in-plant technologies available to tanneries. It is the physical separation or segregation of at least the two major wastewater streams in a tannery. One stream originates in the beamhouse, is highly alkaline and contains a substantial organic load of dissolved and suspended hair. The other stream originates in the tanyard, is acidic, and has a chrome content of measurable level.

These two major and substantially different wastewater streams can be most effectively pretreated as separate streams rather than in a combined state. Constituent streams of these two major streams are the specific process waste streams which may also respond better to separate treatment. Effective segregation techniques that should be considered include the following physical systems (USEPA 1979):

- Processing equipment (e.g., hide processors) can be connected by in-place piping to holding tanks for reuse or segregated discharge to treatment.
- Below grade sewers can be installed to serve process and rinse tanks with similar wastewater characteristics.
- Above grade sewers can be installed to serve process and rinse tanks.
- Curbs and dikes may be required to ensure wash waters are segregated adequately.
- Flow diversion gates may be useful to segregate concentrated wastes in periodic dumps from low-concentration wastewaters.

Control of Specific Waste Constituents

The specific waste constituents associated with the industry may be targeted for removal in-plant. The waste constituents that could merit such consideration include (USEPA 1979):

- Lime Reduction. Lime used in unhairing liquors is responsible for the alkalinity of the final effluent. Insoluble calcium compounds simply add to the sludge quantity. Though the pH of the mixed effluent has to be sufficiently high to precipitate chromium salts, it is desirable to reduce the amount of lime to a minimum. It is reported: "Because lime has a limited solubility, it is generally regarded as a safe alkali for use in unhairing. Consequently, tanners are tempted to use a considerable excess of this material--far more than is needed to satisfy the alkali-binding capacity of the skin collagen and to keep the liquor saturated with lime. Experiments have shown that the amount of lime needed for effective unhairing is less than is required to saturate the protein so there is certainly no justification for any undissolved lime to be present in beamhouse liquors" (USEPA 1979).

- Chrome Reduction. Tanyard wastewater is generally acidic and, because of the chrome content, is toxic to some organisms. The acidic nature of the waste stream can be neutralized by mixing with the beamhouse wastes that are alkaline or by pH adjustment with chemicals. The chrome content can be reduced by using one of a number of technologies. One technique is to increase the uptake of chrome by the leather in tanning. A second is to reuse chrome liquors, as is, in some part of the beamhouse, tanyard, or retan process without first recovering the chrome from the solution. A third way is to precipitate the chrome with an alkaline chemical, producing a chrome sludge either for disposal or for chrome recovery. The alkaline chemical source can be beamhouse waters, fresh lime, or bases such as caustic soda or soda ash.

  Aside from their application as methods of reducing the chrome content in tannery wastewater some of these methods have been used in the past as chrome conservation methods. During World War II, chrome supplies were cut off and tanners were able to reduce their chrome use 20% (USEPA 1979). Under current conditions of increasing chrome prices and reduced imports, an economic incentive exists for tanneries to introduce these methods of chrome conservation, which will improve the wastewater quality as well. In fact, several tanneries have already started chrome recovery and reuse programs.

  Increasing the uptake of chrome is an effective method of reducing chrome in the wastewater and conserving chrome. Chrome fixation can be increased by increasing the chrome concentration, increasing the temperature, adjusting the concentration of neutral salts to the minimum required to prevent swelling of the hides, increasing the basicity of the chrome waste slightly, and adjusting the pH of the tanning liquor during the tanning process. Some of these methods may affect the quality of the leather (USEPA 1979). After World War II, tanners went back to the older methods. The efficiency of chrome use is now about 70% (USEPA 1979).

- Sulfide Removal. In situ sulfide oxidation in the drum or paddle with the hides has been investigated and is in use. TNO Institute investigated this method of oxidizing sulfides in the lime liquors during and after the liming process (USEPA 1979). It was found that a vigorous movement of the liquor and a free air supply are very important. In the alkaline medium, the manganese catalyst converts into insoluble manganous hydroxide. Flotation of the hydroxide by hair remnants or foam must be prevented to retain the catalytic activity. When the oxidation of sulfides is combined with the liming operation the latter

> is started in the usual way, either in a paddle or in a drum. After complete removal of the hair, a small amount of manganous sulfate, (e.g., 200 g/cubic meter (m^3)), is added and paddling or drumming is continued for some additional time. Using hair-burn liming procedures and the lowest sulfide concentrations necessary for complete unhairing and the production of good quality leather, over 95 percent of the residual sulfides could be removed by oxidation within three hours. This additional drumming had little effect on the appearance and physical properties of the leather produced in this way.
>
> The TNO technique of in situ sulfide oxidation in combination with a sulfide liquor reuse system reduced the sulfide content of the wastewater discharged to POTW from 118 mg/l to about 2 mg/l concurrent with a reduction in wastewater volume.

Ammonia Reduction in the Bating Operation

The major source of ammonia nitrogen and total Kjeldahl nitrogen (TKN) in the tanning industry is from the bating or deliming operation. Ammonium sulfate or ammonium chloride are the two most frequently used deliming salts. They can be used either alone or in combination with acid for deliming. When combined with acid, they create a buffer solution which is capable of neutralizing the residual lime in the hide without drastically reducing pH, which would cause acid swelling. Significant reductions in the concentration of ammonia in wastewater effluents can be achieved by substituting other bating salts or by using weaker deliming acids in place of the commonly used ammonium salts. Both magnesium sulfate and magnesium chloride have been substituted successfully and their use should be given consideration as an in-plant pollution abatement measure (Koopman 1974). Weak acids such as boric acid and sodium bisulfate can be used to delime hides prior to tanning without the use of a bating salt buffer solution. These acids are effective and can avoid swelling the hide, but they are not widely used because they increase processing time.

Recycle of Unhairing Liquor

Results of small-scale trials on recycling of lime-sulfide unhairing liquors have been reported in which the liquors have been recycled up to 27 times without deterioration in leather quality (USEPA 1979). Different soak methods were compared to determine which did not cause a build-up of salt in the liquor that would affect the swelling and unhairing. Matched-side trials were conducted comparing:

1. conventional unhairing and unhairing with lime recycle after solids removal;
2. conventional unhairing and unhairing with lime recycle and no solids removal; and
3. unhairing using lime recycle with solids and unhairing using lime recycle without solids.

None of the trials produced inferior quality leather. Fats were found to accumulate in recycled lime liquors when the solids were not removed. Advantages stated are the improved effluent quality and the savings in water use. The work has been extended to large-scale tannery trials.

Enzyme Unhairing for Hair-Save Operations.

Prerequisities for any hair-saving method are: it must unhair easily and mechanically, with removal of fine hair (if possible without reliming); it must be economical, not time-consuming; it must be suited to mechanized and automated production processes; and it must give good leather quality. Hair-saving processes require more labor than hair-burn processes, and tanners will not incur additional costs unless there is a profit from the proceeds of the hair and a cost savings in wastewater treatment. Present trends in the industry are definitely toward the hair-burn process.

Summary of Industry Efforts to Implement In-Plant Controls

Table 1 previously has listed some feasible in-plant process change methods and indicates the number of tanneries which have considered and decided either positively or negatively to implement these in-plant changes. Sulfide substitution and elimination of bating were widely considered but the tanners found no solution which, in their experience, did not interfere with leather quality. Fourteen tanners considered a substitute for ammonium sulfate and one tannery is successfully using magnesium sulfate in deliming with no problem in leather quality and with a considerable reduction in nitrogen waste load.

As indicated in the table, opinion is almost equally divided on the use of hide processors and also almost equally divided on lime and unhair liquor reuse. Some tanners state that the leather produced in hide processors is of poorer quality, while others state that the leather is of better quality and the hide processors improve in-plant control. Some tanners think that hide processors are more economical because less labor is required and lower water use results. Others object to the cost of installation and problems of maintenance.

In lime and unhair liquor reuse the question focuses on labor and materials savings, lower waste load, and questionable leather quality. Several of the responses recorded on Table 1 in the negative column included comments which indicated that decisions are still pending and that further studies are being conducted.

Decisions on protein recovery apparently depend on the economic situation of each tannery. The important question involves the volume, quality, and the market for recoverable protein. Reuse or recovery of tan liquors is generally an economic question with most decisions indicated on that basis. From the questionnaires it also appears that wash water and cooling water reuse is usually implemented if convenient and if the tanner perceives some real benefit from such an investment.

It is quite evident that many of these in-plant technologies are well established and that a different cost situation (e.g., the cost of ammonia removal by treatment versus elimination by substituting chemicals) will motivate tanners to further implement these pollution control methods. As the cost of processing chemicals and POTW cost recovery and operating charges increase, the cost-effectiveness for many of these in-plant control technologies will also become more attractive. Chrome recovery is an excellent example of the cost of processing chemicals making recovery economically attractive as well as environmentally sound.

3.2.2 End-of-Plant-Controls

The Federal Water Pollution Control Act, as amended by the 1977 Clean Water Act, does not require the use of specific treatment technologies. Instead, it leaves to the discretion of the individual tannery the selection of control technologies to meet the New Source Performance Standards (NSPS) for effluent control. The selected technology may involve end-of-plant controls only or may involve a combination of in-process and end-of-plant controls. The technologies described in this section have been identified as appropriate to achieve NSPS effluent controls, but should not be interpreted as the only approved technology to meet NSPS (USEPA 1979). These descriptions should be considered as generally applicable for the entire industry, except as indicated.

The New Source Peformance Standards (NSPS) for each subcategory of the leather tanning industry were presented in Section 1.5, Table 4. These proposed NSPS include:

- Non-toxic, Non-conventional Pollutants. These include total Kjeldahl nitrogen, ammonia, and sulfide.
- Toxic Pollutants. These include phenol and chromium.
- Conventional Pollutants. These include the conventional pollutants, BOD, COD, TSS, oil and grease.
- Indicator Pollutants. These include BOD_5, COD, TSS, oil and grease, TKN, ammonia, phenol, and chromium.

Control of toxic pollutants by controlling indicator pollutants has been proposed by USEPA because it has been found that control technologies that remove these materials also remove toxic compounds (e.g., priority pollutants) that are present. Because regulation based on specific analysis of all the various priority pollutants identified in tannery waste would place a severe financial and administrative burden on the tanneries without a commensurate benefit to the environment, the alternative of selected indicator pollutant control was developed (USEPA 1979).

3.2.2.1 Preliminary Treatment

The need for preliminary treatment or pretreatment is based on the following factors:

1. Removal of pollutants found to pass through a POTW with inadequate treatment.
2. Removal of causes of treatment system upset or hazards and of collection system obstructions or potentially damaging materials.
3. Stringent water quality criteria imposed upon POTW in NPDES permits.
4. Reduction of load to secondary treatment units.
5. Sludge disposal criteria.

Preliminary treatment operations consist of one or combinations of the following operations and processes:

1. screening;
2. equalization;
3. sulfide oxidation;
4. carbonation of beamhouse wastewaters; and/or
5. ammonia nitrogen removal.

- Screening. Fine screening removes hair particles, wool, fleshings, hide trimmings, and other large-scale particulates. While reducing undesirable wastewater constituents, screening contributes to the volume of solid waste which must be disposed. The highly putrescible wastes are commonly disposed of on-site or at remote landfill operations.

- Equalization. Equalization of waste streams is important in pretreatment facilities. The volume and strength of waste liquors vary depending on process formulations and scheduling of tannery operations. Alkaline wastes are associated with beamhouse operations, while acid discharges arise from the tanyard. In order to produce optimum results in subsequent treatment operations, the equalization of flow, strength, and pH of strong liquors may be necessary. Although some oxidation may occur, no removal of waste constituents is normally reported for equalization.

- Sulfide Oxidation. Sulfides in the beamhouse waste constitute a potential problem because they will release hydrogen sulfide if mixed with wastes which can reduce the pH of the sulfide-bearing waste.

  The removal of sulfides is not accomplished with plain sedimentation. Sulfides are more satisfactorily removed through oxidation. Various methods for oxidizing sulfides include: air oxidation; direct chemical oxidation; and catalytic air oxidation.

- Carbonation of Beamhouse Waste Stream. Carbonation is effective in the treatment of alkaline wastes. In this process, carbon dioxide reacts with lime to form calcium carbonate, which has a solubility of only 25 to 50 mg/l. The crystalline structure of the carbonate nucleus provides an effective surface for adsorption of organic matter. Suspended solids and BOD_5 are both reduced. Inorganic suspended solids in the form of calcium carbonate are significantly reduced and thus reduce excessive alkalinity, which in turn reduce mixing requirements in activated sludge aeration basins and secondary sludge production and dewatering requirements.

  Carbonation is attractive for tannery pretreatment facilities, where carbon dioxide is available at the cost of piping from the plant boilers. Removals are high, under proper operating conditions, for suspended solids and BOD_5.

- Ammonia Nitrogen Reduction. Ammonia is difficult to remove from tannery wastewaters. Biological systems which remove BOD have not been effective in removing ammonia. For this level of treatment, EPA considered several alternatives for removing ammonia from deliming wastes by physical-chemical treatment processes. The ammonia introduced into the tannery wastewater stream by the deliming process ranges from 67 to 90% of all the ammonia in the raw waste. Thus, substitution for ammonia or treatment of this ammonia containing stream will greatly reduce the final ammonia content of the total wastewater effluent.

  These processes assure that the primary ammonia containing stream is segregated and the ammonia removed before it is combined with other waste streams. The segregated ammonia containing stream has a higher concentration of ammonia than a combined stream, and it is therefore easier to treat by physical-chemical methods. The methods considered were:

  1. water evaporation followed by crystallization or precipitation of ammonium sulfate;
  2. distillation of ammonia;
  3. precipitation of ammonia as calcium ammonium phosphate;
  4. precipitation of ammonium sulfate by addition of ethanol;
  5. reverse osmosis; and
  6. ion exchange.

  No tannery now uses these methods for treating ammonia wastes. Several of them are technologies used in other industries while others should work because of known chemical principles.

3.2.2.2 Primary Treatment (Physical) Operations

These operations are designed to remove suspended pollutants from the wastewater stream, to reduce solids loadings to subsequent units, and also to reduce organic loads.

- Plain Sedimentation. Plain sedimentation is concerned with the removal of non-flocculating discrete particles and floatable low-density materials such as grease and scum. Suspended solids reductions can range from approximately 40 to 90%, with associated reductions in BOD_5 from 30 to 60%. Much of the suspended material removed is insoluble lime which produces a voluminous and heavy sludge. Although grease removals are not indicated, high removals are expected with surface skimmers installed in clarifiers. While high removals of suspended solids (90%) and BOD_5 (60%) are reported, effluent concentrations are not reported below 130 mg/l for suspended solids or 146 mg/l for BOD_5 (USEPA 1979). High chromium removals may result while sulfide concentrations are relatively unaffected.
- Chemical Coagulation and Sedimentation. As an alternative to plain sedimentation, chemical addition prior to sedimentation has further increased the removal efficiencies of primary clarifiers. Chemical coagulation results in higher removals of suspended solids, BOD_5, sulfides, chrome, and alkalinity through flocculation of colloidal particles. Alum, lime, iron salts, and polymers have exhibited satisfactory results. Suspended solids removals from 50 to above 98% and BOD_5 reductions of approximately 50 to 99% may be achieved (USEPA 1979). The following removals have been conservatively established for coagulation-sedimentation of leather tanning wastewaters: BOD_5 - 60%; TSS - 65%; COD - 60%; Oil and Grease - 70%; Total Chromium - 90%; TKN - 65%.

3.2.2.3 Secondary (Biological) Treatment

Preliminary treatment and primary treatment do not remove all of the organic material in a wastewater stream. Most of the BOD_5 and suspended solids can be removed by biological processes which oxidize the organic materials. Many different systems are known for the biological oxidation of wastewater. In these systems bacterial respiration is the primary method of oxidizing organic substances present in the wastewater. This results in a substantial reduction of the effluent BOD. The higher level of treatment generally includes one or more biological unit processes following primary treatment. Secondary biological treatment technology includes activated sludge, various kinds of lagoons, and trickling filters. Selection of one of these biological treatment systems is influenced by factors such as wastewater constituents, effluent requirements, climatic conditions, site constraints, operating characteristics, and economics. It has been repeatedly observed in tanneries and other industrial operations that waste treatment systems achieve the design effluent quality only if: (1) the design is correct for the wastewater characteristics; (2) the system is not overloaded, (i.e., pollutant and hydraulic loading not more than 100% of design specifications); and (3) all components of the system receive regular and necessary maintenance.

- Trickling Filter Systems. Trickling filter systems are used to treat tannery wastewater by very few tanneries (USEPA 1979). Trickling filters have limited application in the treatment of high strength tannery wastes. System upsets are common due to organic overload and climatic conditions. Existing filters may be incorporated into systems for treatment prior to a second stage biological system.

- Lagoons. Lagoons, also referred to as oxidation ponds or stabilization ponds, have been used for tannery treatment where land is available as an economical alternative to activated sludge. Lagoons provide equalization and a desirable environment for biological activity. In lagoons with long retention times, primary and secondary clarification may be eliminated. However, the efficiency of these systems is significantly reduced during cold weather and sludge accumulation will eventually make it necessary to construct a new lagoon or dredge the old one. The three types of lagoons available for the stabilization of organic wastes include:

  Aerobic Lagoons. Biological stabilization in the presence of oxygen. These include lagoons that incorporate mechanical methods (i.e., stirring, spraying, or bubbling) to increase the dissolved oxygen content in the lagoon.

  Anaerobic Lagoons. Biological stabilization in the absence of free oxygen.

  Aerobic/Anaerobic Lagoons. A stratified lagoon where aerobic activity predominates near the surface and anaerobic activity takes place near the bottom of the lagoon.

- Activated Sludge Systems. The activated sludge process is one of the most controllable and flexible of all secondary treatment systems. It is applicable to almost all treatment situations. With proper design and operational control and use, high organic removals are possible. Designs based on solids retention time (SRT) afford optimum residence time for solids with minimal hydraulic retention. However, pilot studies are recommended to establish appropriate design parameters defining the relative rate of biological growth and decay with a given wastewater. Basically, the activated sludge process consists of: mixing of returned activated sludge with the waste to be treated; aeration and separation of the activated sludge from the mixed liquor; and disposal of the excess sludge. Activated sludge is typically preceded by some form of primary treatment especially in tannery applications. Activated sludge systems, including various modifications, such as extended aeration, carousel, and oxidation ditch (Barber 1978) have been and can be effective in organic reductions to low BOD_5 concentrations. Removals of suspended solids appear to be dependent on the design and operation of the final clarifier. During the program for preparation of the Development Document, BOD removal from 89 to 98% and suspended solids removal from 90 to 98% were observed (USEPA 1979).

- Rotating Biological Contactor. The rotating biological contactor (RBC) consists of a series of closely spaced flat parallel disks which are rotated while partially immersed in wastewaters being treated. A biological growth covering the surface of the disk adsorbs dissolved organic matter present in the wastewater. As the biomass on the disk builds up, excess slime is sloughed off periodically and is settled out in sedimentation tanks. The rotation of the disk carries a thin film of wastewater into the air where it adsorbs the oxygen necessary for the aerobic biological activity of the biomass. The disk rotation also promotes thorough mixing and contact between the biomass and the wastewaters. Rotating biological contactors could be used as a substitute for an entire aerobic system. The number of stages required depends on the desired degree of treatment and the influent strength. More typical applications of the rotating biological contactors, however, may be for polishing the effluent from biological processes, nitrification of effluents, and as pretreatment prior to discharging wastes to a municipal system. A BOD_5 reduction of 98% is reportedly achievable with a four-stage RBC.

- Nitrogen Control-Nitrification. Nitrification is the biological conversion of nitrogen in organic or inorganic compounds from a more reduced to a more oxidized state. In the field of water pollution control, nitrification usually is referred to as the process in which ammonia as ammonium ion is oxidized to nitrite and nitrate sequentially. Process controls are critical for nitrification to be successful. Dissolved oxygen should be maintained above 1 to 2 mg/l to assure consistent nitrification. System pH for domestic wastewater has been shown critical, with pH 7.5 to 8.5 the optimum range. Since nitrification generates acidity (excess of hydrogen ions), a buffered wastewater, either naturally or by addition of alkaline chemicals, is required to maintain the optimum pH range. Nitrification is extremely temperature sensitive, with a minimum of 12 to 15° C required for effective treatment. Sulfides should be reduced to less than 1 mg/l and chrome reduced to 2 to 10 mg/l to avoid inhibitory effects on nitrification. Nutrients are critical as for all biological systems, with phosphorus normally required for a tannery wastewater.

- Nitrogen Control-Denitrification. Denitrification, the conversion of nitrites and nitrates (primarily nitrates) to nitrogen is accomplished under much less stringent conditions and with a larger range of organisms than nitrification. The process consists of biologically reacting a carbon source (essentially fuel), such as residual organic pollutants or methanol, glucose, methane, or low nitrogen organic waste, with the nitrite-nitrate, oxidizing the carbon source to CO_2 by using the oxygen from the nitrite-nitrate, and liberating nitrogen gas. Many denitrification processes are designed to use methanol as the carbon source because of ease of process control, cost, and water and bacteriological compatibility.

- Nitrogen Control-Summary. Nitrification-denitrification has not been applied to tannery wastes on a full scale, but the technology has been applied to a variety of wastes. Total nitrogen reduction can range from 30 to 90% with removal efficiencies extremely dependent on system operation.

3.2.2.4 Advanced Physical-Chemical Processes

There are several technologies available for the new source tannery that the applicant might consider. These are not used by the industry at this time, but they could be effective in meeting NSPS.

- Combined Primary and Secondary Treatment. Physical-chemical processes have been proposed for treating wastewater streams where all pollutant components can be flocculated and removed by sedimentation. Such a system for the leather tanning industry has been patented by Chappel (USEPA 1979) using an acidic solution (mineral acid, aluminum sulfate, and oxidizing chemicals) and an alkaline solution (sodium hydroxide, dissolved aluminum, and oxidizing chemicals). Separate treatment with these solutions is given to two segregated wastewater streams from the tannery, after which these are combined. Flocculation and pollutant removal is reported for both separate treatment and after combining the streams. Sludge is recirculated to aid in flocculation. When this system was used on a retan facility wastewater, removal efficiencies were reported at 99+% for BOD, 95+% for TKN and ammonia, and 99+% for chrome. When the process was tested on other tanneries, it was found similarly effective for BOD, chrome, and sulfides.

- Powdered Carbon Addition to Activated Sludge. This process involves metering activated carbon into the activated sludge facility influent. The process effectiveness relies on the processes complementing each other and thereby improving overall treatment effectiveness. Improvements reported include:

  - improved organic pollutant removals, including BOD, COD, and TOC;

  - more uniform operation and effluent quality, particularly during periods of widely varying organic and hydraulic loads;

  - decreased effluent solids and thicker sludges resulting in reduced sludge handling costs;

  - adsorption of organics, such as detergents, oils, and dyes, that are refractory to the biological system;

- protection of the biological system from toxic waste components;

- more effective removal of phosphorus and nitrogen; and

- increased effective plant capacity at little or no additional capital investment.

A major inhibition to the widespread use of granular activated carbon has been the high capital cost of installing thermal regeneration facilities in small installations. A possible solution to this problem has been developed by a major chemical company whereby customers can lease carbon adsorption systems at a guaranteed monthly charge. The company assumes the responsiblity for regeneration at central facilities.

- Multi-media Filtration. With the exception of gravity sedimentation, deep-bed filtration is the most widely used unit process for liquid-solids separation. Deep-bed filters have been employed in systems for phosphorus removal from secondary effluents, and in physical-chemical systems for the treatment of raw wastewater. Waste containing suspended solids is passed through the filter containing granular material resulting in the capture of suspended solids in the bed. Eventually, the pressure drop through the bed becomes excessive or the ability of the bed to remove suspended solids is impaired. The filtration cycle is terminated and the bed is backwashed prior to being placed back into service. In an ideal filter, the size of the particles should decrease uniformly in the direction of flow. This condition is partially achieved with the use of a multimedia deep bed filter. This type of filter utilizes materials with different densities ranging from the large size particles at the top of the filter having the lowest density and the smallest particles at the bottom of the filter having the highest density. With this arrangement, the filter has a large storage capacity for suspended solids, and is able to remain in operation for longer periods of time. Influent solids should be limited to about 100 mg/l to avoid too frequent backwashing. Effluent suspended solids are normally less than 10 mg/l. The following conservative long-term performance is reasonable after application to PAC upgraded activated sludge effluent: BOD_5 - 14 mg/l; TSS - 16 mg/l; Oil and Grease - 6 mg/l; COD - 40 mg/l; Total Chromium - 0.25 mg/l; TKN - 15 mg/l.

- Electrodialysis. Various membrane processes that are finding interest in pollution control applications as end-of-pipe treatment and for in-plant recovery systems are ultrafiltration, reverse osmosis, and electrodialysis. Although these processes are available for producing a concentrated solution from a relatively dilute feed, each process tends to occupy a specific region of application due to economic as well as technological considerations.

  Whenever an effluent stream contains an organic or inorganic ionic material, electrodialysis offers a possible method for recovery, separation, segregation, or concentration of that material, provided adequate pretreatment requirements are consistently achieved. Of paramount importance, of course, is the avoidance of membrane fouling, either by scaling or suspended solids, when considered for tannery applications. Other conditions such as pH fluctuations and dissolved organic solids concentrations also must be carefully controlled if electrodialysis is used in the tannery. Yet, with water recovery rates of 80-90%, greatly reduced disposal volumes, the independence of chemical additives and low energy requirements, electrodialysis streams may be an economically feasible means of meeting the parallel challenge of wastewater treatment and recovery through brine concentrations.

- Nitrogen Removal. While biological removal methods are effective for control of ammonia in wastewater effluents, various physical-chemical methods are also available. In general, the following systems might be effective for treatment of a segregated, ammonia-bearing wastewater from the deliming process:

    - Use of alternative deliming agents, such as epsom salts.
    - Evaporation of water followed by crystallization or precipitation of ammonium sulfate.
    - Distillation of ammonia.
    - Precipitation of ammonia as calcium ammonium phosphate.
    - Precipitation of ammonium sulfate by addition of ethanol.
    - Reverse osmosis.
    - Ion exchange.

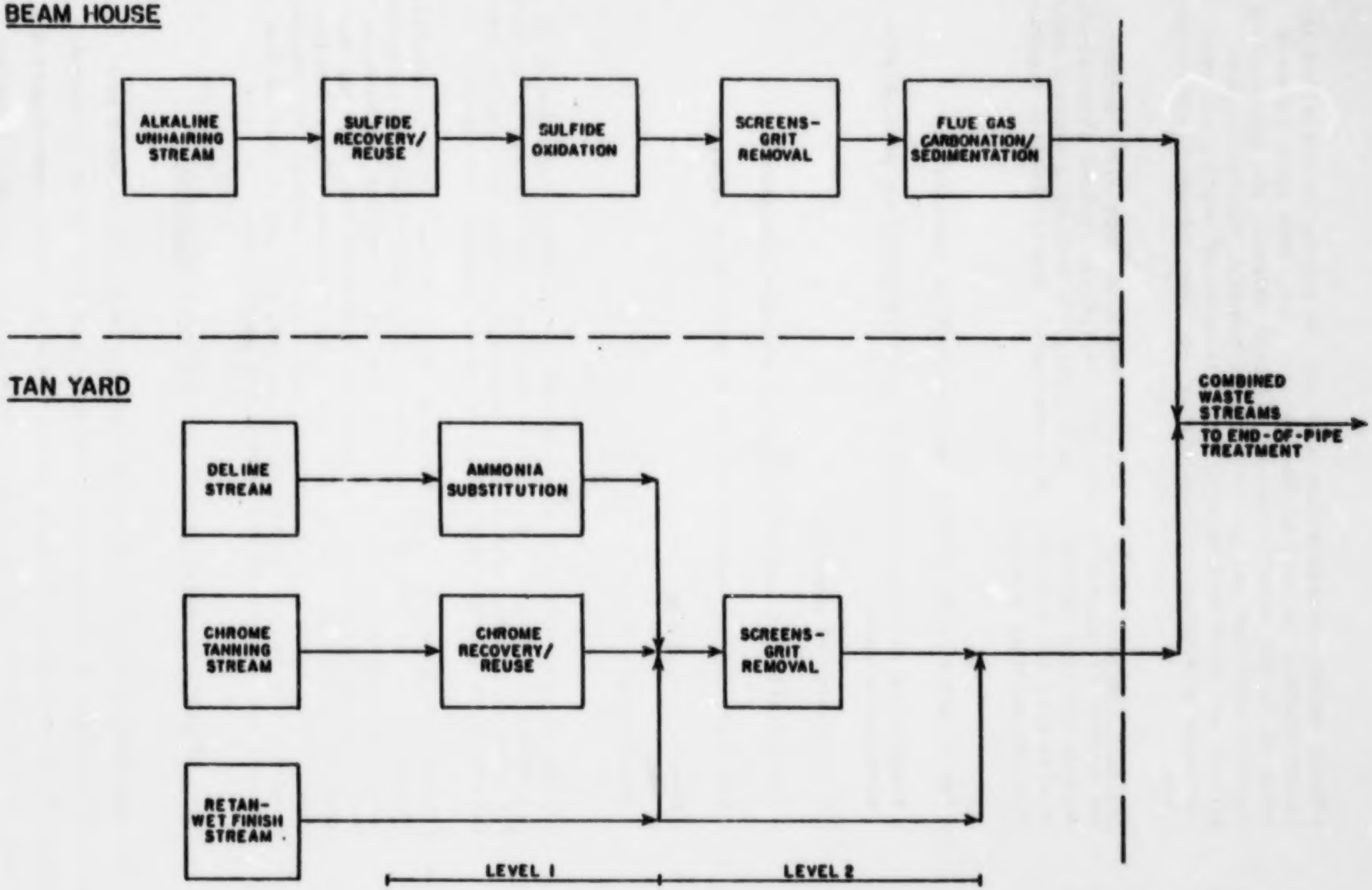
    The use of alternative deliming agents is now being investigated in the industry. None of the other technologies are now used in a tannery for treating ammonia wastes, but these technologies are used in other industries or should work because of known chemical principals.

- Protein Precipitation. The beamhouse waste stream can be successfully treated to reduce COD, BOD, nitrogen, dissolved solids, and suspended solids contributed by the unhairing process. Proposed technologies include plain and chemical coagulation, sedimentation, flue gas carbonation, screening, filtration, and centrifugation. The effectiveness of this technique on the total waste stream varies. The removed materials are largely proteinaceous matter, and can be used as feed for chickens when supplemented with key amino acids.

Summary of Waste Control and Treatment Technology

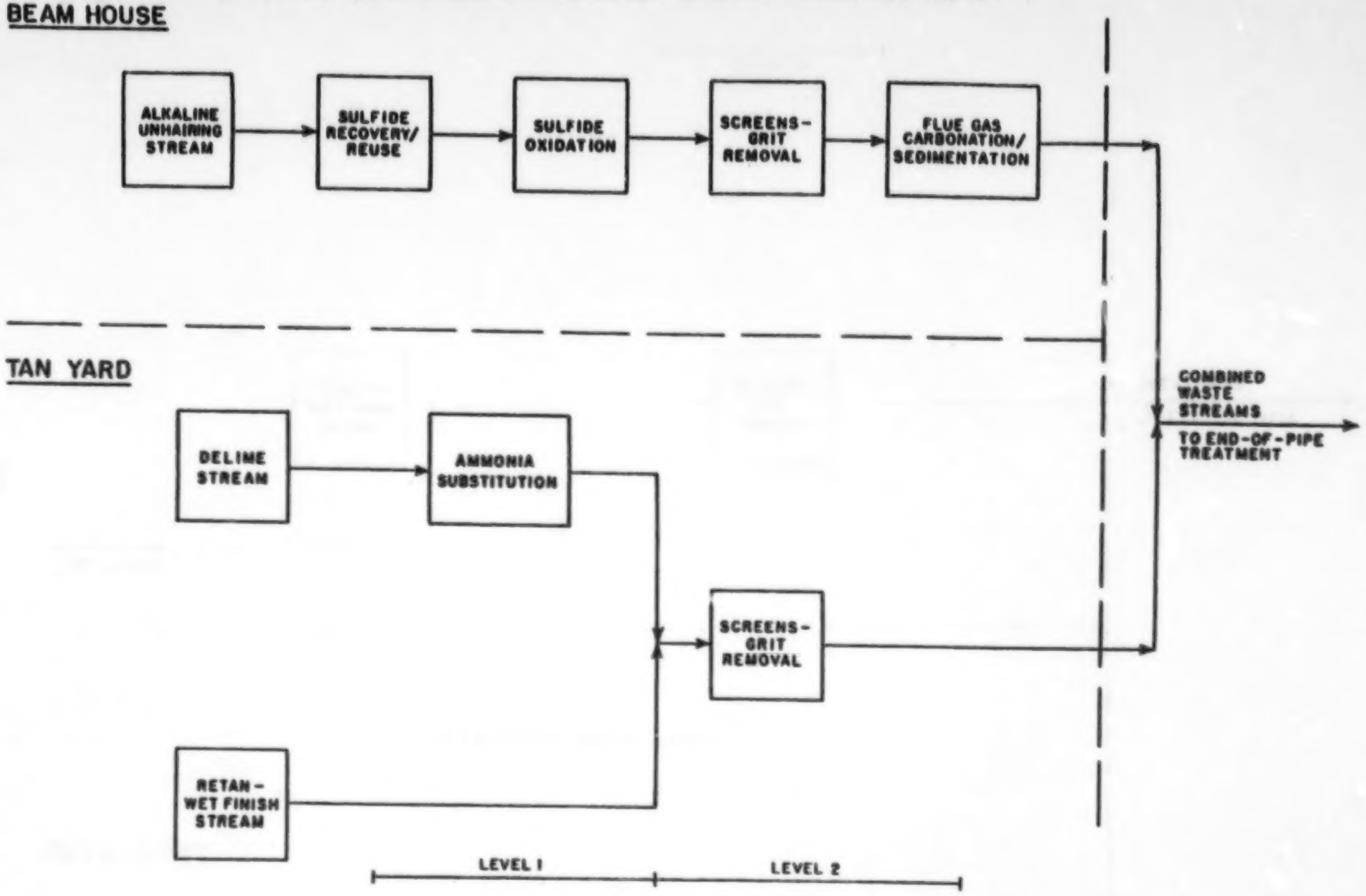
The preceding discussion addresses numerous technologies which can be employed in-plant or end-of-pipe to minimize the quantity of pollutants discharged by tanneries to POTW's or surface waters. These technologies are pertinent to the leather tanning industry because they (1) reflect current

Figure 7. Technology schematic for in-plant control and preliminary treatment for the hair pulp/chrome tan/retan-wet finish and hair save/chrome tan/retan-wet finish subcategories.


BEAM HOUSE
ALKALINE UNHAIRING STREAM
SULFIDE RECOVERY/ REUSE
SULFIDE OXIDATION
SCREENS- GRIT REMOVAL
FLUE GAS CARBONATION/ SEDIMENTATION
TAN YARD
DELIME STREAM
AMMONIA SUBSTITUTION
CHROME TANNING STREAM
CHROME RECOVERY/ REUSE
SCREENS- GRIT REMOVAL
RETAN- WET FINISH STREAM
LEVEL 1
LEVEL 2
COMBINED WASTE STREAMS
TO END-OF-PIPE TREATMENT

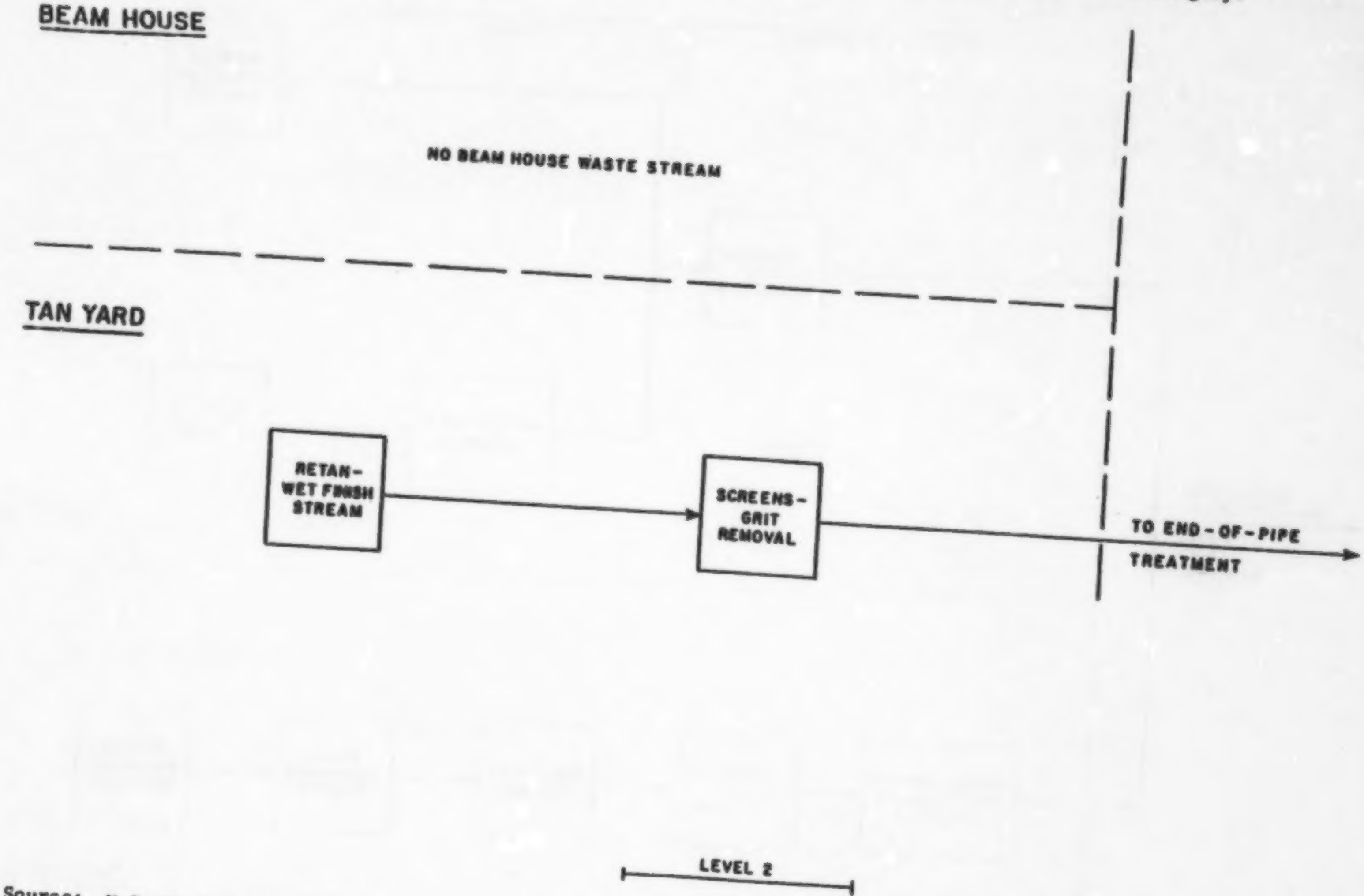
Source: U.S. Environmental Protection Agency. 1979. Preliminary draft development document for proposed effluent limitations guidelines and new source performance standards for the leather tanning and finishing industry.

Figure 8. Technology schematic for in-plant control and preliminary treatment for the hair save/non-chrome tan/retan-wet finish subcategory.


BEAM HOUSE
ALKALINE UNHAIRING STREAM
SULFIDE RECOVERY/ REUSE
SULFIDE OXIDATION
SCREENS-GRIT REMOVAL
FLUE GAS CARBONATION/ SEDIMENTATION
TAN YARD
DELIME STREAM
AMMONIA SUBSTITUTION
RETAN-WET FINISH STREAM
SCREENS-GRIT REMOVAL
COMBINED WASTE STREAMS
TO END-OF-PIPE TREATMENT
LEVEL 1
LEVEL 2

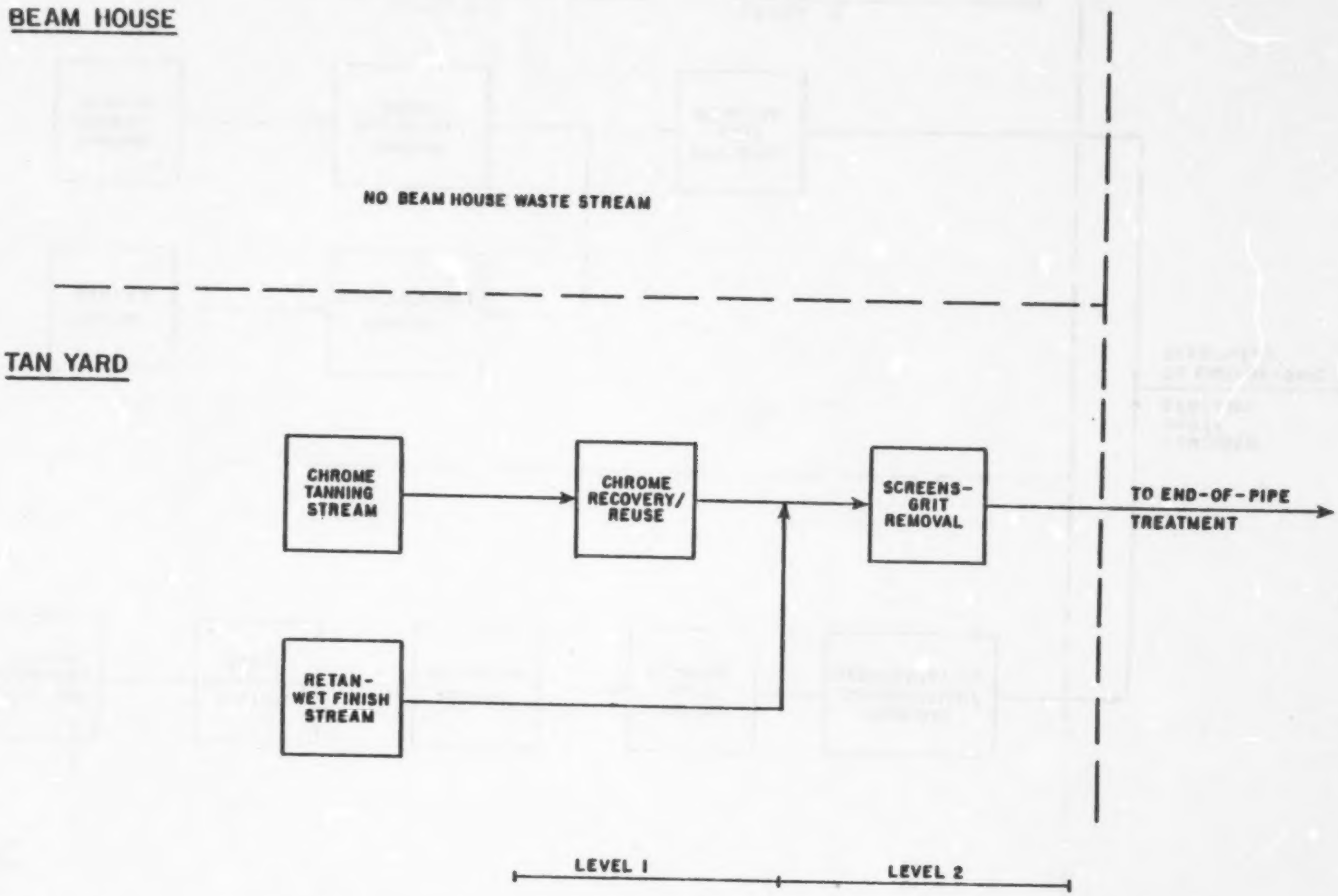
Source: U.S. Environmental Protection Agency. 1979. Preliminary draft development document for proposed effluent limitations guidelines and new source performance standards for the leather tanning and finishing industry.

Figure 9. Technology schematic for in-plant control for the retan-wet finish subcategory.


BEAM HOUSE
NO BEAM HOUSE WASTE STREAM
TAN YARD
RETAN-WET FINISH STREAM
SCREENS-GRIT REMOVAL
TO END-OF-PIPE TREATMENT
LEVEL 2

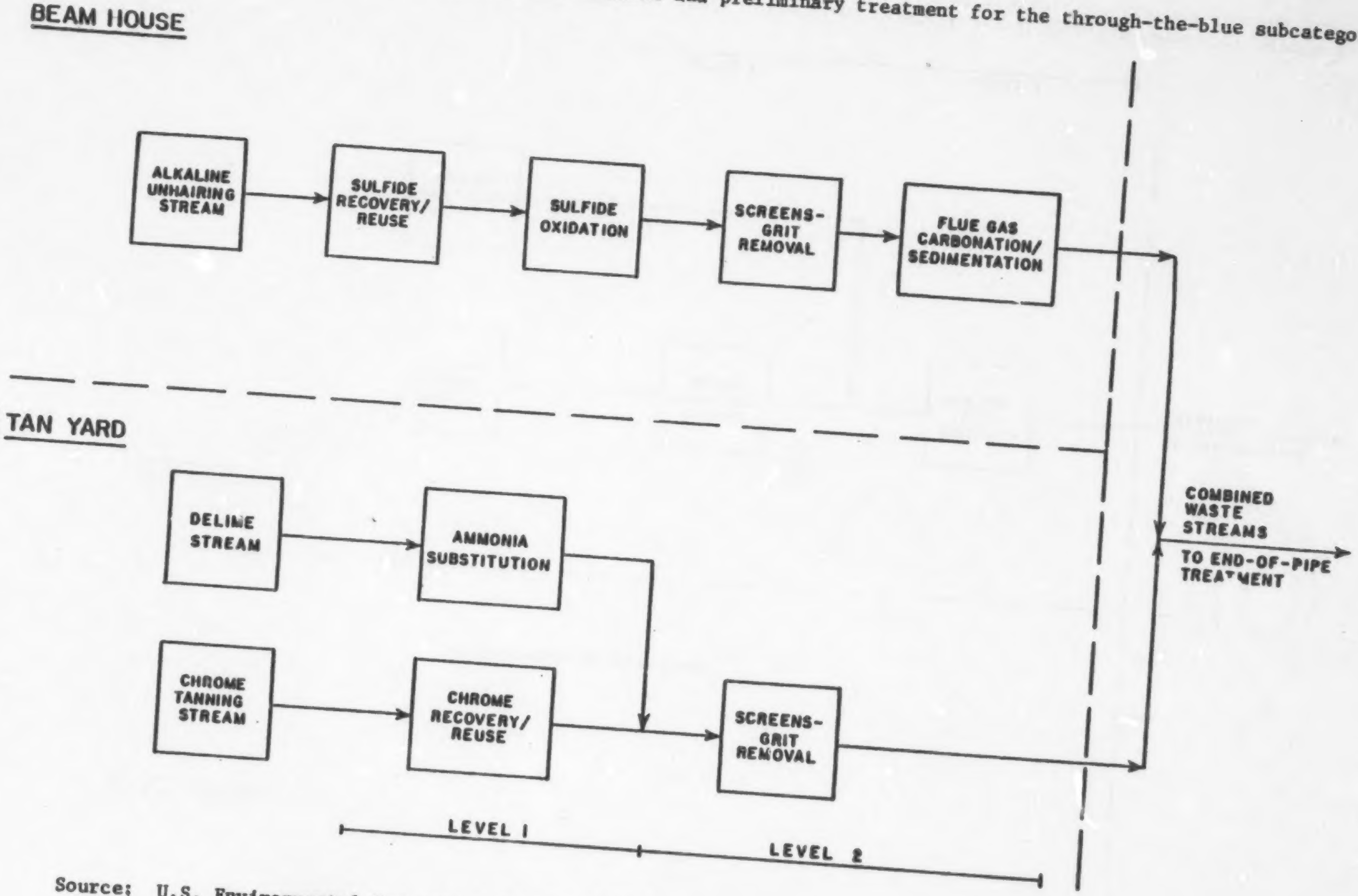
Source: U.S. Environmental Protection Agency. 1979. Preliminary draft development document for proposed effluent limitations guidelines and new source performance standards for the leather tanning and finishing industry.

Figure 10. Technology schematic for in-plant control for the no beamhouse and shearling subcategories.


BEAM HOUSE
NO BEAM HOUSE WASTE STREAM
TAN YARD
CHROME TANNING STREAM
RETAN-WET FINISH STREAM
CHROME RECOVERY/REUSE
SCREENS-GRIT REMOVAL
TO END-OF-PIPE TREATMENT
LEVEL 1
LEVEL 2

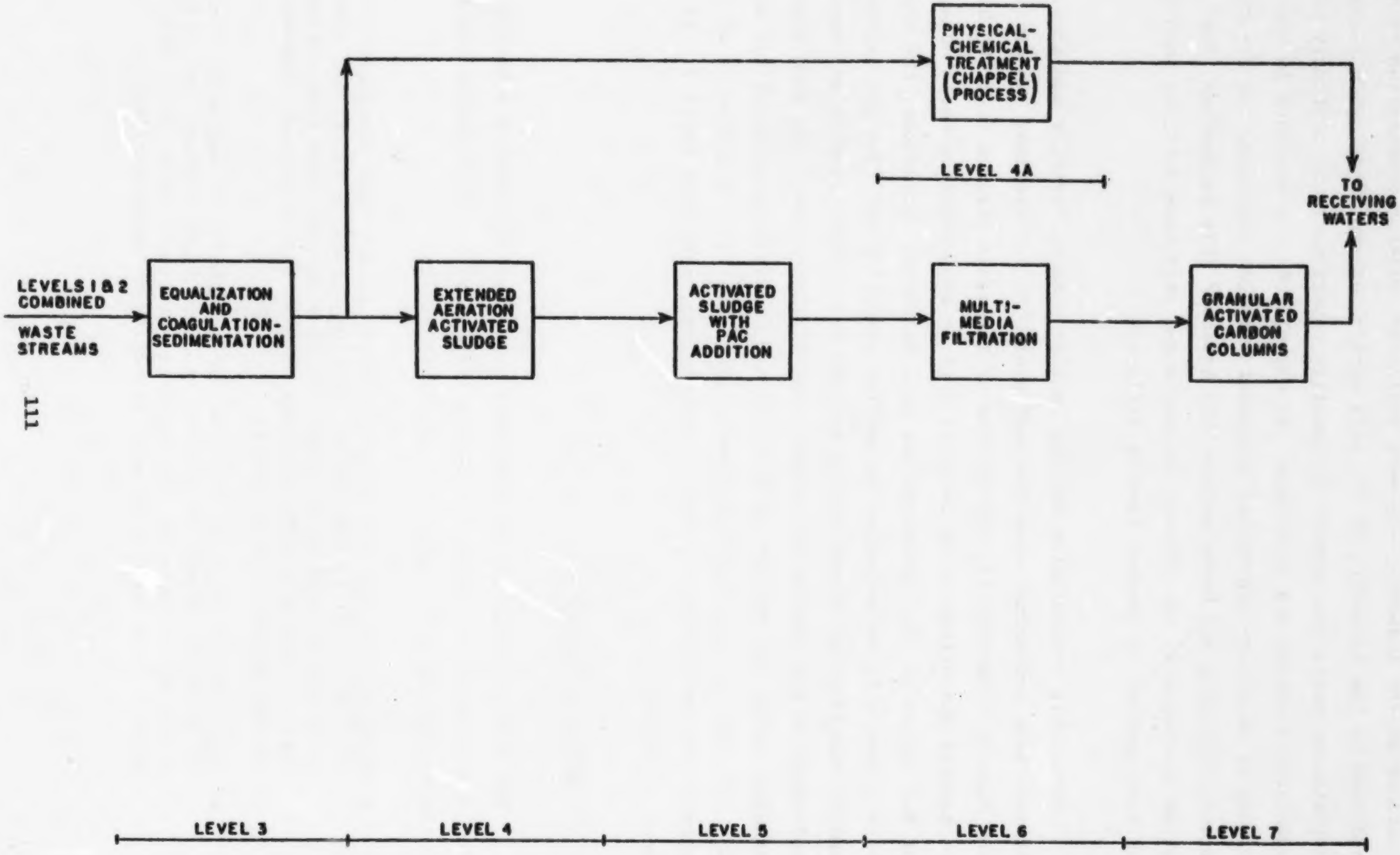
Source: U.S. Environmental Protection Agency. 1979. Preliminary draft development document for proposed effluent limitations guidelines and new source performance standards for the leather tanning and finishing industry.

Figure 11. Technology schematic for in-plant control and preliminary treatment for the through-the-blue subcategory.


BEAM HOUSE
ALKALINE UNHAIRING STREAM
SULFIDE RECOVERY/ REUSE
SULFIDE OXIDATION
SCREENS-GRIT REMOVAL
FLUE GAS CARBONATION/ SEDIMENTATION
TAN YARD
DELIME STREAM
AMMONIA SUBSTITUTION
CHROME TANNING STREAM
CHROME RECOVERY/ REUSE
SCREENS-GRIT REMOVAL
COMBINED WASTE STREAMS
TO END-OF-PIPE TREATMENT
LEVEL 1
LEVEL 2

Source: U.S. Environmental Protection Agency. 1979. Preliminary draft development document for proposed effluent limitations guidelines and new source performance standards for the leather tanning and finishing industry.

Figure 12. Technology schematic for end-of-pipe wastewater treatment.


LEVELS 1 & 2 COMBINED
WASTE STREAMS
EQUALIZATION AND COAGULATION-SEDIMENTATION
EXTENDED AERATION ACTIVATED SLUDGE
ACTIVATED SLUDGE WITH PAC ADDITION
MULTI-MEDIA FILTRATION
GRANULAR ACTIVATED CARBON COLUMNS
PHYSICAL-CHEMICAL TREATMENT (CHAPPEL PROCESS)
LEVEL 4A
TO RECEIVING WATERS
LEVEL 3
LEVEL 4
LEVEL 5
LEVEL 6
LEVEL 7

Source: U.S. Environmental Protection Agency. 1979. Preliminary draft development document for proposed effluent limitations guidelines and new source performance standards for the leather tanning and finishing industry.

practices of the industry, (2) were evaluated during demonstration studies conducted by the industry, or (3) will control or remove selected pollutants. In instances where the control of specific constituents is a primary concern, technology transfer was necessary. An example of this approach is the upgrading of secondary biological treatment with PAC addition. To control toxic organic compounds and heavy metals, EPA assessed this technology from information developed by the organic chemicals and petroleum refining industries and then applied to leather tanning effluents.

Applicable technologies for the leather tanning industry and their performance were determined upon the best available information. As can be seen from Figures 7 through 11, segregation of the waste streams from the beamhouse and tanyard operations is an integral part of comprehensive waste management for the industry. For subcategories with beamhouse operations, the segregated waste stream will be subjected to sulfide oxidation and flue gas carbonation. Ammonia substitution in the bating process and chrome recovery and reuse are applicable to the tanyard processes. The effluents resulting from these measures, which are defined as Levels 1 and 2, are then combined for equalization followed by coagulation-sedimentation (Level 3). A schematic of the appropriate end-of-pipe treatment technologies, including Level 3, is provided in Figure 12.

3.2.3 Toxic Pollutants

The effectiveness of the treatment processes described previously has been investigated for toxic pollutants (USEPA 1979). The conclusions relating to the removal of these materials are (USEPA 1979):

- Volatile organics are largely removed in any type treatment system that is in use in the leather tanning industry, except for some degree of persistence of chloroform. It also appears that this occurs regardless of treatment effectiveness on any other pollutant parameters whether standard or priority.
- Semivolatile organics also receive a significant degree of removal by all waste treatment systems in use. Those systems that are most effective in removing the standard pollutants (COD, BOD_5, TSS, Oil and Grease) also seem to be most effective on semivolatiles.

- Metals comprise the inorganic groups of toxic pollutants and include chromium. All of the treatment systems remove the metals to some extent, and performance on the metals seems to correlate with removal of standard pollutants. The most effective treatment system on metals is the physical-chemical system.
- The fate of the toxic pollutants is not certain. It is highly probable that a substantial percentage of the pollutants are removed with the solids separated from the wastewater.
- Toxic pollutant removal effectiveness in general correlates with standard pollutant removal.

The Pretreatment Standards for New Sources (PSNS) have been proposed as equivalent to NSPS due to the control requirements for priority pollutants (USEPA 1979). Therefore, the technologies previously described would also be considered as appropriate for new leather tannery and finishing facilities that propose discharge to a publicly owned treatment works.

3.3 SOLID WASTE - STANDARDS OF PERFORMANCE TECHNOLOGY

As described in Section 2.3, solid waste from a tannery with a wastewater pretreatment/treatment system may include any or all of the following:

- Fleshings.
- Hair.
- Hide trimmings.
- Tanned hide trim and shavings.
- Leather trimmings.
- Buffing dust.
- Leather finishing residues.
- Wastewater treatment sludges.
- General plant waste.

The specific types of solid waste generated by a tannery depend upon the type of processing operations conducted, and the quantity of each type of waste generated depends upon the volume of production at the tannery.

In view of the hazardous nature of much of the tanning industry's wastes, there is reason for concern over concentrating priority pollutants removed from the other plant waste streams in the plant's solid waste. The fate of the priority pollutants as they are removed from tannery waste is unknown at this time. Currently, the predominant assumption is that a significant proportion of these pollutants remains intact in the solids that are removed from the wastewater. These solids are subsequently disposed in landfills and dumps with varying levels of control (SCS Engineers 1976). Identification of four tannery processes as hazardous waste sources under the proposed RCRA regulations (Section 1.5) may help reduce the uncertainty concerning the fate of some priority pollutants, but the entire solid waste stream for a new tannery should be thoroughly evaluated.

3.3.1 Reduction of Hazardous Waste Components

The primary contaminants of solid tannery wastes are chromium, zinc, lead, and copper, with smaller but unknown quantities of organic and inorganic priority pollutants also present. In-plant process modifications to eliminate the use of as many of the priority pollutants as possible at their source would obviously reduce their concentration in solid tannery residuals. Reuse and/or recovery of waste streams containing chrome, dyes, or other toxic pollutants not only reduces the contamination of solid waste residuals but makes more efficient use of materials which, as in the case of chrome, are becoming increasingly more expensive. Some metals are introduced into the waste stream as corrosion products from tannery equipment. Alternative construction materials should be considered as a possible means of reducing the introduction of metals from this source.

When the treatment of segregated waste streams produces a solid waste, the specific contaminants in the solids are generally known and these contaminants are in their most concentrated form. Solid wastes in this form are most manageable in terms of control and appropriate disposal. Taken in general perspective, numerous small quantities of solid waste of more concentrated composition are generally more economical to handle and transport, and are much more environmentally manageable than a single, large, dilute, and multicontaminated solid waste from a POTW.

3.3.2 Solid Waste Utilization

Tanneries which generate fleshings and hide trimmings may be able to sell these waste materials to rendering plants, or occasionally to glue manufacturers. Since these waste materials are highly putrescible, daily collection is required. Most vegetable leather tanneries and a few chrome leather tanneries remove hair from hides using a hair save operation. If a market is available, the hair can be washed, dried, and baled, and subsequently sold as a by-product. Since few markets exist, however, most hair is simply disposed of in a landfill.

Some chrome leather tanneries which generate large quantities of tanned hide trimmings and shavings, particularly split leather tanners located in the northeastern United States, are able to sell this waste material as a by-product. By-product uses include manufacture of fertilizer, chrome glue, hog feed supplement, or leather board. The majority of this type of waste, however, is disposed as solid waste.

Four alternative uses for scrap leather examined in a report for the Tanners Council of America (1977) and summarized in the effluent guidelines development document (USEPA 1979) were:

- Incineration of blue split and finished leather waste.
- Fiberized leather for loose building insulation.
- Pyrolyzed leather waste to make activated carbon and by-product chemicals.
- Hydrolyzed leather and cattle hair to make leather and hair meals for use in animal and pet foods.

Possible economic incentives exist for each of these alternative uses. However, their actual application has been limited to date. Such alternatives could be economically viable for new plants. More information on these alternative uses may be found in USEPA's Development Document (USEPA 1979).

3.3.3 Solid Waste Treatment

Approximately 60% of the solid waste generated by the leather tanning and finishing industry is wastewater treatment residue (SCS Engineers 1976). Therefore, a major part of tannery waste treatment involves the handling and disposal of the semi-solid sludges obtained from liquid treatment processes.

Primary and/or secondary treatment sludge from chrome tanneries normally is dewatered prior to disposal. Sludge dewatering may be accomplished by:

- Gravity dewatering (sequential settling). This is relatively uncommon, but sludge drying beds on the tannery plant site may be successful where rainfall is less than evaporation.
- Mechanical sludge dewatering. Normally this is accomplished using vacuum filters, centrifuges, or filter presses, which have all been found to be effective in producing sludge cakes ranging from 10 to 40% solids.
- Evaporative lagoons. Secondary wastewater treatment sludges from vegetable tanneries are normally dewatered in this manner, after which the sludge is used as a soil conditioner or disposed of in a dump or landfill.

Conditioning or stabilization of waste treatment plant sludge using heat treatment provides a stable end product, but may have adverse effects on the chemical quality of the sludge. In testing a heat-treated alkaline sludge, it has been indicated that some of the trivalent chromium may be oxidized to the more soluble and toxic hexavalent form. Apparently, the trivalent chromium is converted through the high temperature, high pressure, high pH, and the oxidizing environment of the heat treatment process (USEPA 1979).

3.3.4 Solid Waste Disposal

The predominant methods of ultimate disposal of tannery waste include sludge lagoons, landfills, dumps, trenches, and land spreading. Some of these facilities are not entirely adequate as disposal sites for hazardous wastes since they do not provide adequate isolation of the hazardous substances from the human environment. Their use will no doubt be eliminated once RCRA regulations regarding hazardous tannery wastes are promulgated. The factors that should be considered during solid waste disposal evaluations include:

- Sludge lagoons, dumps, landfills, and land spreading areas present the potential for leaching of toxic materials into the groundwater table.
- Incineration, pyrolysis, wet oxidation, or similar high temperature and pressure sludge destruction processes can generate hexavalent chromium, which is more soluble than trivalent chromium in the acid range of pH generally found in landfills.

- Acetic acid produced by the anaerobic decay of garbage in landfills can solubilize trivalent chrome, increasing its susceptibility for leaching, and can contribute to oxidation of trivalent chrome to hexavalent chrome.

- Leather finishing residues may contain significant quantities of flammable organic solvents, indicating that disposal sites which receive this type of waste need to take precautions to minimize the potential fire hazard from this material. The quantities of this type of waste which are generated are small enough that land disposal is thought to be an environmentally adequate disposal alternative.

A hazardous waste disposal site must be carefully selected to minimize surface water flow across the site, and the predominant soil types should be able to contribute to leachate attenuation. Operational procedures should be employed which will minimize percolation of precipitation through the refuse. Leachate collection systems at landfills used for hazardous solid waste disposal are recommended to include impermeable barriers as a minimum to provide adequate assurance that ground and surface waters will be protected from contamination. Monitoring wells around the site also are recommended to detect any break-through or leachate before it spreads to other areas.

Tannery wastes such as vegetable tannery sludge, general plant waste (strings, paper, boxes), and uncontaminated scraps or hair may be nonhazardous and therefore amenable to disposal in a regular landfill. This would require segregation from the potentially hazardous wastes. Since these potentially nonhazardous wastes make up a relatively small portion of the industry's total solid waste production, it may not be economical to dispose of them separately.

4.0 EVALUATION OF AVAILABLE ALTERNATIVES

The alternatives section of the EID should address each reasonable alternative available for the new source leather tanning and finishing facility. The purpose of this analysis is to identify and evaluate alternate plans and actions that may accomplish the desired goals of the project. These alternatives can include process modifications, site relocations, project phasing, or project cancellation.

For the alternatives to a proposed project to be identified and evaluated properly, the impact assessment process should commence early in the planning phase. In this manner, social, economic, and environmental factors against which each alternative is to be judged can be established. Cost/benefit analysis should not be the only means whereby alternatives are compared. The environmental and social benefits of each alternative also must be considered. In general, the complexity of the alternative analyses should be a function of the magnitude and significance of the expected impacts of the proposed processing operations. A small tannery that uses purchased raw materials or existing by-products may have a relatively minimal impact on a region and generally would require fewer alternatives to be presented in the EID.

The public's attitude toward the proposed operation and its alternatives also should be evaluated carefully. In this way key factors such as aesthetics, community values, and land use can be assessed properly.

4.1 SITE ALTERNATIVES

New leather tanning facilities are usually located on the basis of the following:

- convenience to hide sources;
- an adequate labor force and water supply;
- proximity to energy supplies and transportation; and
- minimization of environmental problems.

Preliminary site selection activities normally take place before the EID document is prepared. The potential impacts that a new leather tanning facility may have on the alternative site areas should be evaluated as to their significance; magnitude; frequency of occurrence; cumulative effects; reversibility; secondary or induced effects; and duration. The identification and analysis of the alternative site areas should be described in the EID and the reasons for eliminating a site(s) should be specified. The EID discussion should particularly emphasize the environmental considerations given during the site selection process. This should particularly identify the existence of sensitive areas, environmental constraints at each considered site (e.g., effluent receiving stream conditions, air quality, water and groundwater conditions), and the significance of these constraints with respect to the specific facility. Consultation with the appropriate resource agencies during the early stages of site selection is recommended. Key agencies that can provide valuable technical assistance include:

- State, Regional, County, or Local Zoning or Planning Commissions. These sources can describe land use programs and determine if variances would be required. Federal lands are under the authority of the appropriate Federal land management agency (Bureau of Reclamation, U.S. Forest Service, National Park Service, etc.).
- State or Regional Water Resource Agencies. These sources can provide information relative to water appropriations and water rights.
- Air Pollution Control Agencies. These sources can provide assistance relative to air quality allotments and other air-related standards and regulations.
- The Soil Conservation Service and State Geological Surveys. These sources can provide data and consultation on soil conditions and geologic characteristics.

Further consideration should be given to any state siting laws. The applicable regulations should be cited and any applicable constraints described.

The EID should include the potential site locations on maps, charts, or diagrams that show the relevant site information. (A consistent identification system for the alternative sites should be established and retained on all graphic and text material.) They should display pertinent information that includes, but is not limited to:

- areas and sites considered by the applicant;
- major centers of population density (urban, high, medium, low density, or similar scale);
- water bodies suitable for cooling water or effluent disposal;
- railways, highways (existing and planned), and waterways suitable for the transportation of materials;
- important topographic features (such as mountains and marshes);
- dedicated land use areas (parks, historic sites, wilderness areas, testing grounds, airports, etc.); and
- other sensitive environmental areas.

Using the foregoing graphic materials, the applicant should provide a condensed description of the major considerations that led to the selection of the final candidate areas, including:

- proximity to markets and raw materials;
- economic analyses with trade-offs;
- adequacy of transportation systems;
- environmental aspects, including the likelihood of floods;
- license or permit problems;
- compatibility with existing land use planning programs; and
- current attitudes of interested citizens.

The EID should indicate the steps, factors, and criteria used to select the proposed site. Quantification, although desirable, may not be possible for all factors because of lack of adequate data. Under such circumstances, qualitative and general comparative statements, supported by documentation, may be used. Where possible, experience derived from operation of other plants at the same site, or at an environmentally similar site, may be helpful in appraising the nature of expected environmental impacts.

Economic estimates should be based at least on a preliminary conceptual design that considers how construction costs are affected by such site related factors as:

- topography;
- geology;
- tectonics; and
- meteorology.

A specific site for location of the leather tanning facility may be unacceptable and require abandonment for a number of reasons. This could include:

- Impact on a unique, recreational, archaeological, or other important natural resource area. Reviews are mandated in the permitting process by several public agencies relative to these factors, including the Soil Conservation Service, Fish and Wildlife Department, State Historic Preservation Officer, and others.
- Destruction of the rural or pristine character of an area.
- Conflict with the planned development for the area.
- Opposition by citizens groups.
- Meteorological and climatological aspects.
- Periodic flooding, hurricanes, earthquakes, or other natural disasters.

4.2 ALTERNATIVE PROCESSES AND DESIGNS

The following presents a methodological approach to the analysis of process and design alternatives. The discussion of specific system alternatives is presented in Section 3.0.

4.2.1 Process Alternatives

Process alternatives are usually selected on the basis of the following:

- product demand;
- reliability of the process;
- economics;
- availability of required raw materials; and
- environmental considerations.

Those alternatives that appear practical should be considered further on the basis of criteria such as:

- land requirements of the tanning facility, fuel storage facilities, waste storage facilities, and exclusion areas;
- release to air of dust, sulfur dioxide, nitrogen oxides, and other potential pollutants, subject to Federal, state, or local limitations;
- releases to water of heat, chemicals, and trace metals subject to Federal, state, and local regulations;
- water consumption rate;
- fuel consumption;
- social impacts of increased traffic as materials are transported to the site and wastes are transported from the site;
- social effects resulting from the influx of construction, operation, and maintenance crews;
- economics;
- aesthetic considerations for each alternative process; and
- reliability and energy efficiency.

A tabular or matrix form of display often is helpful in comparing the feasible alternatives. The EID should present clearly and systematically the methodology used to identify, evaluate, and select the preferred process alternative. Alternative processes which are not feasible should be dismissed with an objective explanation of the reasons for rejection.

4.2.2. Design Alternatives

In order to properly present alternative facility designs available for the project in the EID, the combination of component systems available for selection should be analyzed and described for the following factors:

- Economic. This should include capital and operating costs.
- Environmental. These should be documented and quantified wherever possible.
- Engineering. System reliability and safety should be discussed in conjunction with product requirements.

4.3 NO-BUILD ALTERNATIVE

In all proposals for industrial development, the alternative of not constructing the proposed new source facility must be considered. This analysis is not unique to the development of leather tanning facilities (see Chapter IV, Alternatives to the Proposed New Source, in the USEPA document, Environmental Impact Assessment Guidelines for Selected New Sources Industries, October 1975). The key aspects of the no-build alternative should be identified to include:

- Market Effect. Not constructing the facility may result in product shortages.
- Industry Effect. Not constructing the facility may cause dated facilities to be renovated.
- Technology Effect. Not constructing the facility may only delay the need for expanded capacity, which may allow time for improved technology to be incorporated into the facility.
- Environmental Effect. Not building the facility might avoid adverse environmental effects at the proposed site, but may therefore cause similar effects at a more sensitive site.

Other factors should be considered (e.g., specific environmental issues) as appropriate for the situation leading to the proposed action.

5.0 REGULATIONS OTHER THAN POLLUTION CONTROL

There are various regulations other than pollution control that may apply to the siting and operation of leather tanning facilities. Some Federal regulations that may be pertinent to a proposed facility include, but are not limited to, the following:

- Coastal Zone Management Act of 1972 (16 USC 1451 et seq.)
- Fish and Wildlife Coordination Act of 1974 (16 USC 661-666)
- National Environmental Policy Act of 1969 (42 USC 4321 et seq.)
- USDA Agriculture Conservation Service Watershed Memorandum 108 (1971)
- Wild and Scenic Rivers Act of 1969 (16 USC 1274 et seq.)
- Flood Control Act of 1944
- Federal-Aid Highway Act, as amended (1970)
- Wilderness Act of 1964
- Endangered Species Preservation Act, as amended (1973) (16 USC 1531 et seq.)
- National Historical Preservation Act of 1966 (16 USC 470 et seq.)
- Executive Order 11593 (Protection and Enhancement of Cultural Environment, 16 USC 470) (Sup. 13, May 1971)
- Archaeological and Historic Preservation Act of 1974 (16 USC 469 et seq.)
- Procedures of the Council on Historic Preservation (1973) (39 FR 3367)
- Occupational Safety and Health Act of 1970
- Executive Order 11988 (Floodplain Management - replaced Executive Order 11296 on 10 August 1966)
- Executive Order 11990 (Wetlands)
- Energy Policy and Conservation Act of 1975
- Energy Conservation and Production Act of 1976

Particular emphasis should be placed on obtaining the services of a qualified archaeologist to determine the potential for disturbance of an archaeological site, such as an early Indian settlement or a prehistoric site. The National Register of Historic Places also should be consulted for historic sites such as battlefields. The appropriate wildlife agency (state and Federal) should be contacted to ascertain that the natural habitat of a threatened or endangered species will not be affected adversely; other resource agencies also should be consulted to avoid or minimize impacts to areas that previously have been determined to be sensitive or uniquely important (wetlands, floodplains, prime farmlands, etc.).

From a health and safety standpoint, most industrial operations involve a variety of potential hazards and to the extent that these hazards could affect the health of plant employees, they may be characterized as potential environmental impacts. Company policy should provide and maintain safe and healthful conditions for employees and establish operating practices that will result in safe working conditions and efficient operations. All proposed plans to maximize health and safety should be described in the EID.

The plant must be designed and operated in compliance with the standards of the U.S. Department of Labor, the Occupational Safety and Health Administration, and the appropriate state statutes relative to industrial safety. Close coordination with local and/or regional planning and zoning commissions is recommended to determine possible building or land use restrictions. State and local regulations may exist that affect the facility, and the EID should indicate that these have been considered.

Table 9 presents a range of typical permits, licenses, certifications, and approvals that could be required from local, regional, state, and Federal officials for construction and operation of a major new source leather tanning facility. Although this list doubtless will vary between jurisdictions, it is intended primarily to be illustrative. The new source NPDES permit review process normally will be expedited by documenting in the EID all known permits, licenses, and approvals that are needed to construct and operate the proposed plant, and the status of each.

Table 9. Typical permits, licenses, certifications, and approvals required from Federal, state, regional, and local authorities for construction and operation of a typical new source leather tanning facility.

Agency	Requirement
Local Planning Organization (regional, county, city)	Rezoning of plant site
	Approval of access road rights-of-way
Local Department of Public Works	Permit for filling or construction operations in flood plains
Local Beautification Board	Construction on public property if required
Local Department of Development and Licensing	Building permit for each structural component of facility
	Use and occupancy permits
State Planning Department	Coastal zone permit, if required
State Fire Marshall	Permit to store flammable liquids
	Approval of facility for fire protection
State Department of Environmental Protection	Water use and discharge permits
	Test well permit
	Commercial well permit
	Permit for dewatering excavation
	Permit for fuel oil storage tanks
	Permit for solid waste disposal
	Dredging and construction of intake structure
	Sedimentation control approval
	Noise control approval
	State water quality certification
	Construction permit for combustion equipment
	Registration of gaseous emissions

Table 9. Typical permits, licenses, certifications, and approvals (continued).

Agency	Requirement
• State Air Pollution Control Department	• Permit for construction of stationary source of air pollutants
	• Open burning of construction refuse
	• Review of indirect (mobile) emission sources
• State Board of Health	• Permit to construct and operate approved sewage disposal and potable water facilities
• State Department of Highways and Transportation	• Permit for highway entrance of plant access road
	• Approval of public road improvements
	• Permits for oversize or overweight vehicles
• US Environmental Protection Agency (Regional Office)	• National Pollutant Discharge Elimination System Permit (NPDES) for wastewater discharge
	• Prevention of Significant Deterioration of air quality (PSD) permit prior to commencement of construction activities
	• Spill Prevention, Control, and Countermeasure (SPCC) plan
	• Hazardous/toxic waste disposal plan
• US Army Corps of Engineers, (District Office)	• Permit to construct structures or works* in navigable waters (Section 10, Rivers and Harbors Act of 1899)
	• Permit to dispose of dredged or fill materials in waters of the US (including wetlands) (Section 404, FWPCA)
(COE, Washington Office)	• Permit to construct any dam or dike in a navigable water of the US (Section 9, Rivers and Harbors Act of 1899)

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* Structures may include piers, breakwaters, bulkheads, revements, and aids to navigation; works may include dredging, stream channelization, excavation and filling.

Table 9. Typical permits, licenses, certifications and approvals (concluded).

Agency	Requirement
	• Permit to ocean dump dredged materials (Section 103, Ocean Dumping Act)
	• Permit to discharge refuse matter into navigable waters of the US or their tributaries (Section 13, The Refuse Act 1899)
	• Test boring on Federal land
• Occupational Safety and Health Administration	• Certification of safety and health criteria for plan operation (noise in the work place, etc.)

6.0 GLOSSARY

Aerobic

A biological process in which oxygen is used for microorganism respiration needs, especially relating to the degradation process of waste matter in the presence of dissolved oxygen.

Anaerobic

A biological process in which chemically combined oxygen is used for microorganism respiration needs; relating to biological degradation of waste matter in the absence of dissolved oxygen.

Back

That portion of the animal hide, especially cattlehide, consisting of the center portion of the hide along the backbone and covering the ribs, shoulders, and butt (excluding the belly).

Bating

The manufacturing step following liming and preceding pickling. The purpose of this operation is to delime the hides, reduce swelling, peptize fibers, and remove protein degradation products from the hide.

Beamhouse

That portion of the tannery where the hides are washed, limed, fleshed, and unhaired when necessary prior to the tanning process.

Belly

That portion of the hide on the underside of the animal, usually representing the thinnest part of the tannable hide.

Bend

That portion of the hide representing the entire hide cut down the backbone with the belly and shoulder removed.

Biochemical Oxygen Demand (BOD_5)

The amount of oxygen required by microorganisms while stabilizing decomposable organic matter under aerobic conditions. The level of BOD is usually measured as the demand for oxygen over a standard five-day period. Generally expressed in mg/l.

Blowdown

The amount of concentrated liquor wasted in a recycle system in order to maintain an acceptable equilibrium of contaminants in any process liquor.

Blue

The state or condition of hides subsequent to chrome tanning and prior to retanning. Hides in this stage of processing are characteristically blue in color.

Buffing

A light sanding operation applied to the grain or underside of leather and also to splits. Buffing smooths the grain surface and improves the nap of the underside of the leather.

Buffing Dust

Small pieces of leather removed in the buffing operation. Buffing dust also includes small particles of abrasive used in the operation and is of a coarse powder consistency.

Carding

Method using a wire brush to disentangle wool. One of the shearling finishing processes.

Chemical Oxygen Demand (COD)

A measure of the amount of organic matter which can be oxidized to carbon dioxide and water by a strong oxidizing agent under acidic conditions. Generally expressed in mg/l.

Chlorine Contact Tank

A detention basin designed to allow sufficient time for the diffusion and reaction of chlorine in a liquid for disinfection purposes.

Chromium (Total)

Total chromium is the sum of chromium occurring in the trivalent and hexavalent state. Expressed in mg/l as Cr.

Clarification

A physical means for the removal of suspended particles in a liquid by gravity sedimentation (settling).

Coagulant

A substance which forms a precipitate or floc when added to water. Suspended solids adhere to the large surface area of the floc, thus increasing their weight and expediting sedimentation.

Collagen

The fibrous protein material within the hide which provides the bulk of the volume of the finished leather and its rigidity.

Colloids

Microscopic suspended particles which do not settle in a standing liquid and can only be removed by coagulation or biological action.

Color

A measure of the light-absorbing capacity of a wastewater after turbidity has been removed. One unit of color is that produced by one mg/l of platinum as $K_2 PtCl_6$.

Coloring

A process step in the tannery whereby the color of the tanned hide is changed to that of the desired marketable product by dyeing or painting.

Combination Tanned

Leathers tanned with more than one tanning agent. For example, initially chrome-tanned followed by a second tannage (called a retan) with vegetable materials.

Composite Sample

A series of small wastewater samples taken over a given time period and combined as one sample in order to provide a representative analysis of the average wastewater constituent levels during the sampling period.

Concrete Mixer

A term often applied to hide processors.

Conditioning

The introduction of controlled amounts of moisture to the dryed leather in order to give it varying degrees of softness.

Corium

The layer of hide between the epidermis and the flesh. Also called the dermis.

Currying

Oil incorporation into leather in a low water system, classically used to lubricate vegetable tanned leather.

Degreasing

In pigskin and sheepskin tanneries a solvent or detergent is added to the drum containing washed hides. Grease is removed from the hides and recovered as a by-product.

Deliming

The manufacturing step in the tanyard that is intended to remove the lime from hides coming from the beamhouse.

Demineralization

The process of removing dissolved minerals from water by ion exchange, reverse osmosis, electrodialysis, or other processes.

Dermis

That part of the hide which is between the flesh and the epidermis.

Desalinization

The process of removing dissolved salts from water.

Detention (Retention)

The dwelling time of wastewater in a treatment unit.

Dewatering

The process of removing a large part of the water content of sludges.

DO

Dissolved oxygen, measured in mg/l.

Drag-out

Loss of process chemicals and solution onto products during processing which is made up by periodic fresh addition of chemicals and solution.

Drum

A large cyclinder, usually made of wood, in which hides are placed for wet processing. The drum is rotated around its axis, which is oriented horizontally. This also may be called a wheel.

Dry Milling

The rotating of leather in a large wooden drum with no added chemicals or water. Dry milling softens the leather.

Electrodialysis

A form of advanced waste treatment in which the dissolved ionic material is removed by means of a series of semipermeable membranes and electric current.

Embossed

A mechanical process of permanently imprinting a great variety of unique grain effects into the leather surface. Done under considerable heat and pressure.

Enzymes

Complex protein materials added to the hide in the bating step in order to remove protein degradation products that would otherwise mar hide quality.

Epidermis

The top layer of skin; animal hair is an epidermal outgrowth.

Equalization

The holding or storing of wastes having differing qualities and rates of discharge for finite periods to facilitate blending and achievement of relatively uniform characteristics.

Equivalent Hides

A statistical term used to relate the production of tanneries using various types of raw materials. An equivalent hide is represented by 3.7 sq m of surface area and is the average size for a cattlehide.

Eutrophication

The excess fertilization of receiving waters with nutrients, principally phosphates and nitrates, found in wastewater which results in excessive growth of aquatic plants.

Fatliquoring

A process by which oils and related fatty substances replace natural oils lost in the beamhouse and chrome tanning processes. Regulates the softness and pliability of the leather.

Finishing

The final processing steps performed on a tanned hide. These operations follow the retan-color-fatliquor processes, and include the many dry processes involved in converting the hide into the final tannery product.

Fleshing

The mechanical removal of flesh and fatty substances from the underside of a hide prior to tanning. In the case of sheepskin tanning, fleshing is often accomplished after the tanning process.

Float

The proper level or volume of skins or hides, chemicals, and water that is maintained in any wet process unit (vats, drums, or processors) within the tannery.

Floc

Gelatinous masses formed in liquids by the addition of coagulants, by microbiological processes, or by particle agglomeration.

Flocculation

The process of floc formation normally achieved by direct or induced slow mixing.

Flume

An open, inclined channel or conduit for conveying water or water and hides.

Grab Sample

A single sample of wastewater which will indicate only the constituent levels at the instant of collection; contrasted to a composite sample.

Grain

The epidermal side of the tanned hide. The grain side is the smooth side of the hide where the hair is located prior to removal.

Grease

A group of substances including fats, waxes, free fatty acids, calcium and magnesium soaps, mineral oils, and certain other non-fatty materials. The grease analysis will measure both free and emulsified oils and greases. Generally expressed in mg/l.

Green Hides

Hides which may be cured but have not been tanned.

Head

That part of the hide which is cut off at the flare into the shoulder; i.e., the hide formerly covering the head of the animal.

Hide

The skin of a relatively large animal, at least the size of mature cattle.

Ion Exchange

The reciprocal transfer of ions between a solid and a solution surrounding the solid. A process used to demineralize waters.

Ionization

The process by which, at the molecular level, atoms or groups of atoms acquire a charge by the loss or gain of one or more electrons.

Liming

The operations in the beamhouse where a lime solution comes in contact with the hide. Liming in conjunction with the use of sharpeners such as sodium sulfhydrate is used either to chemically burn hair from the hide or to loosen it for easier mechanical removal. Hair burning normally utilizes higher chemical concentrations.

Multi-Media Filter

A filtration device designed to remove suspended solids from wastewater by trapping the solids in a porous medium. The multi-media filter is characterized by fill material ranging from large particles with low specific gravities to small particles with a higher specific gravity. Gradation from large to small media size is in the direction of normal flow.

Nitrogen, Ammonia

A measure of the amount of nitrogen which is combined as ammonia in wastewater. Expressed in mg/l as N.

Nitrogen, Kjeldahl (Total Kjeldahl Nitrogen or TKN)

A measure of nitrogen combined in organic and ammonia form in wastewater. Expressed in mg/l as N.

Nitrogen, Nitrate

A measure of nitrogen combined as nitrate in wastewater. Expressed in mg/l as N.

Nutrient

Any materials used by a living organism which serve to sustain its existence, promote growth, replace losses, and provide energy. Compounds of nitrogen, phosphorus, and other trace materials are particularly essential to sustain a healthy growth of microorganisms in biological treatment.

Outfall

The final outlet conduit or channel where wastewater or other drainage is discharged into an ocean, lake, or river.

Pack

Layers of salted hides formed at the slaughterhouse or hide curing firm (usually approximately 20 to 40 feet in area and 5 to 6 feet high).

Paddle Vat (Paddle)

A vat with a semi-submerged rotating paddle arrangement used for the mixing of water and chemicals with the hide.

Pasting

The process step generally following the retan-color-fatliquor operations whereby the hide is attached to a smooth plate with a starch and water paste and dried in a controlled heated vessel.

pH

The reciprocal logarithm of the hydrogen ion concentration in wastewater expressed as a standard unit.

Pickling

The process that follows bating whereby the hide is immersed in a brine and acid solution to bring the skin or hide to an acid condition; prevents precipitation of chromium salts on the hide.

Plating

The finishing operation in which the skin or hide is "pressed" in order to make it smoother. Plating may be done with an embossing plate which imprints textured effects into the leather surface.

Polymer

An organic compound characterized by a large molecular weight. Certain polymers act as coagulants or coagulant aids. Added to the wastewater, they enhance settlement of small suspended particles. The large molecules attract the suspended matter to form a large floc.

POTW

Publicly owned treatment works (i.e., municipal waste treatment system).

ppm

Parts per million. The expression of concentration of constituents in wastewater, determined by the ratio of the weight of constituent per million parts (by weight) of total solution. For dilute solutions, ppm is essentially equal to mg/l as a unit of concentration.

Pullery

A plant where sheepskin is processed by removing the wool and then pickling before shipment to a tannery.

Pulp

Method of unhairing in which depilatory agents are used to dissolve hair entirely in a few hours.

Retanning

A second tanning process utilizing either the natural tanning material (chromium or vegetable extracts) or synthetic tanning agents. Retanning imparts specialized properties to the leather.

Reverse Osmosis

A process whereby water is forced to pass through semipermeable membranes under high pressures. Water passing through the membrane is relatively free of dissolved solids; solids are retained in concentrated form on the feed side of the membrane and are wasted.

Sanding

A dry operation performed on the tanned and fatliquored hide in order to achieve the desired surface texture of the leather. Sanding operations include the use of abrasive or buffing wheels.

Sedimentation

Clarification (settling).

Setting Out

A multi-purpose operation which smoothes and stretches the skin while compressing and squeezing out excess moisture. Puts hides into proper condition for drying.

Sharpeners

Chemicals (such as sodium sulfide and sodium sulfhydrate) used in addition to lime to assist in the unhairing process.

Shaving

An abrasive, mechanical action used to correct errors in splitting and thus yielding a uniformly thick grain side or split.

Shavings

The waste products generated during the shaving operations. These are essentially small pieces of the tanned hide, which are approximately the size of wood shavings.

Shearling

A lamb or sheepskin tanned with the hair retained.

Shoulder

That part of the hide between the neck and the main body of the hide.

Side

One-half of a hide, produced by cutting the hide down the backbone. Normally done to facilitate processing using smaller equipment than would be required if full hides were processed.

Skin

The pelt or skin of animals smaller than mature cattle (e.g., pigskin, sheepskin, calfskin).

Skiver

The thin layer shaved or cut off the surface of finished leather, principally sheepskin.

Sludge

A concentrate in the form of a semi-liquid mass resulting from settling of suspended solids in the treatment of sewage and industrial wastes.

Split

A side which has been cut parallel to its surface to provide one large piece of leather of approximately uniform thickness and a thin, smaller piece of non-uniform thickness called a split.

Staking

Mechanically softens the leather by stretching and flexing it in every direction. Usually done on automatic machines which move leather between rapidly oscillating, overlapping fingers.

Sulfide

Ionized sulfur. Expressed in mg/l as S.

Suspended Solids (SS)

Constituents suspended in wastewater which can usually be removed by sedimentation (clarification) or filtration.

Syntan

Synthetic tanning materials, generally used in combination with vegetable, mineral, or formaldehyde tannages. Syntans are almost exclusively used in retanning rather than tanning operations.

Tannin

The chemicals derived from the leaching of bark, nuts, or other vegetable materials used in the vegetable tanning process.

Tanyard (Tanhouse)

That portion of the tannery in which the bating, pickling, and tanning are performed on the hides or skins.

Toggling

Method of drying in which skins are kept in a stretched position by means of clips called toggles. The skin is attached to a perforated frame which is slid into a drying oven.

Total Dissolved Solids (TDS)

The total amount of dissolved materials (organic and inorganic) in wastewater. Expressed in mg/l.

Total Solids (TS)

The total amount of both suspended (TSS) and dissolved (TDS)materials in wastewater. Expressed in mg/l.

Trimming

The removal of the ragged edges and inferior portions of hides and skins either before or after tanning. Trimming is normally accomplished by workers using knives.

Trimmings

The hide and leather scraps produced during the trimming operation.

Unhairing

The process whereby the hair is removed from the hide.

Volatile Solids

Solids, dissolved or suspended, which are primarily organic and during stabilization exert the significant portion of the BOD_5.

Weir

A control device placed in a channel or tank which facilitates measurement or control of the water flow.

7.0 REFERENCES

The literature references in this section include cited references and additional bibliographic references. The listings immediately below are short form citations arranged according to topics. A complete listing of full references, arranged alphabetically, follows the short form citations.

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